ANNALS OF SURGERY

VOL. LII SEPTEMBER, 1910 No. 3

ORIGINAL MEMOIRS.

A CONTRIBUTION TO THE SYMPTOMATOLOGY AND SURGICAL TREATMENT OF SPINAL CORD TUMORS.

BY J. RAMSAY HUNT, M.D.,

OF NEW YORK,

Chief of the Neurological Clinic of the Cornell University Medical School; Neurologist to the New York, City and Babies' Hospitals, and to the New York Hospital for Nervous Diseases,

AND

GEORGE WOOLSEY, M.D.,

OF NEW YORK,

Surgeon to Bellevue Hospital; Professor of Anatomy and Clinical Surgery in Cornell University.

CLINICAL PAPER BY DR. HUNT.

Introduction.—It is now a little over twenty years since Gowers and Horsley described their classical case of tumor of the spinal cord with successful extirpation and recovery. The reports which followed during the next ten years were, on the whole, very encouraging. In the last decade, however, with a more exact knowledge of the symptomatology and an improved surgical technic, this field has become one of the most promising in neurological surgery.

In Starr's [1] contribution to this subject published in 1895, 123 cases of spinal cord tumor were analyzed, in 22 of which an extirpation of the growth was attempted; of this number 11

died soon after the operation, recovery from the paraplegia taking place in six cases only.

A few years later, Collins [2] analyzed 70 cases which had been recorded subsequent to the publication of Starr's statistics. Of these, 30 received surgical treatment, in 12 of which the result was successful, and in eight only partially successful. In 10 cases the result was unsuccessful or fatal. Among the 40 cases of this series in which no operation was attempted, the autopsy revealed an operable tumor which could have been removed in 14.

In the more recent contributions, the percentage of recoveries is even higher; Schultze,[3] in 1903, recorded a series of seven cases of extramedullary tumor, in which extirpation of the tumor was attempted, with three recoveries. Two years later Oppenheim [4] published three successful cases in a series of six operations; and Pearce Bailey [5] in a recent paper reports six cases in which extirpation was attempted, with three recoveries, one doubtful case, and one death.

In Oppenheim's [6] latest discussion of the surgery of spinal cord tumors (1907), the statement is made that recovery takes place in about 50 per cent. of the cases presenting a typical clinical picture of extramedullary growth. Our operative statistics of tumors having this localization are even more favorable and I am convinced that with greater precision in diagnosis and an improved surgical technic, they will eventually be much better.

The series of cases forming the basis of this paper represents my clinical experience in this field, during the past ten years. Thirteen cases in all are recorded, of which six were extramedullary neoplasms. Of this latter group, one died as the result of the operative procedure; one survived the operation for nearly a year, the growth eventually recurring; and the four remaining cases may be regarded as successful, all the patients making fair recoveries from their paralysis and after a considerable lapse of time showing no symptoms of recurrence. In five other cases, an exploratory laminectomy was performed, but the nature or localization of the growth pre-

cluded removal. In a recent case of intramedullary tumor of the cervical region, an exploratory operation was performed and the cord was punctured, with the evacuation of two drachms of cystic fluid. Of the remaining two cases, the diagnosis was confirmed at autopsy, and these are included as contributions to the symptomatology of the subject.

I wish to express my thanks to Professor Dana for the privilege of observing and reporting a number of these cases, as well as for his valuable aid in the problems of diagnosis and localization. I am also indebted to Dr. Joseph Fraenkel for the privilege of observing Case I and to Dr. Abrahamson for a similar courtesy in Case V. The operations, in eight of the cases, were performed by Dr. Woolsey, who will treat in detail the surgical aspects of this subject. In two cases, exploratory laminectomy was performed by Dr. Frank Hartley and in one case by Dr. Bern B. Gallaudet.

Remarks on the Symptomatology of Cord Tumors.—The symptomatology of tumors of the spinal cord is dependent upon the nature and localization of the growth, and the relation which it bears to the long axis and the surface of the cord. It may be laid down as a general rule, that any group of symptoms indicating a progressive focal lesion of the cord should suggest the possibility of neoplasm. This is all the more important as recent observations have shown that many important and characteristic symptoms of tumor may be absent during the entire course of the disease.

The clinical picture of tumor in this region generally begins with *localized pain* due to involvement of the vertebral column, meninges, or more especially, the posterior roots. The pain is followed, after a variable period of time, by symptoms of gradual compression of the cord (sensory and motor paralyses and sphincter disturbances).

With vertebral and extradural tumors, these symptoms, both radicular and medullary, are usually bilateral, often even in the initial stage, while with intradural growths a unilateral symptomatology is more frequent, this often persisting for a considerable period. Exceptions, however, occur to both of these general rules.

Root pains are important, both as general and localizing symptoms. They may persist for years before the appearance of any medullary symptoms, and during this time are the cause of frequent errors in diagnosis. When these pains are situated in the extremities, they are often mistaken for neuralgia, neuritis, and rheumatism; and when referred to the trunk, are sometimes regarded as gastralgia, gall-stones, angina pectoris, appendicitis, and other visceral affections. These root symptoms, so characteristic when present, may fail entirely, and errors in diagnosis may often be attributed to this cause.

A zone of *hyperæsthesia* corresponding to the upper level of the compression is often present, but is far from constant. When demonstrable it has a definite localizing value.

Rigidity of the vertebral column, with localized pain and tenderness, are very characteristic of tumors of the spinal column. Such vertebral symptoms may accompany also intravertebral growths, and, when well defined, may be of distinct localizing value. In my own experience, vertebral symptoms are usually absent in intraspinal growths. Changes in the percussion note at the affected level of the canal have also been noted, but I was unable to demonstrate this symptom in any of my cases.

Extra- and Intramedullary Tumors.—In my series of cases, the general diagnosis of tumor and the localization in the long axis of the cord for purposes of laminectomy have not presented serious obstacles. I have, on the contrary, had great difficulty in deciding whether a tumor was an intra- or extramedullary growth. It is well to remember that some forms of chronic myelitis, multiple sclerosis, and even the early stages of certain systemic diseases of the cord, may simulate very closely the symptomatology of tumor. A careful study of such cases will usually reveal the true nature of the affection, but when in doubt and when a differentiation cannot be made, the patient should always receive the benefit of the doubt and exploratory laminectomy be performed without undue delay.

In this connection, the question of localized serous accumu-

lations within the meninges (meningeal cysts)[7] is of importance; for while these cystic accumulations may occur primarily, producing the typical clinical picture of tumor, they occasionally accompany chronic affections of the cord and vertebra (Oppenheim[8]), and their evacuation in the course of an exploratory operation might be attended with beneficial results.

The differential diagnosis of intra- and extramedullary growths is often so difficult, that in many cases it is impossible to reach a definite conclusion. As the extramedullary tumor alone offers the hope of successful extirpation, the recognition of this group is most important. But here again, when the clinician is in doubt, exploration is indicated and should be undertaken before the disease has progressed too far. I have more than once had occasion to witness exploratory laminectomy in doubtful cases, in which, even if the tumor could have been removed, the cord was already irretrievably damaged.

An extramedullary tumor, when situated beneath the dura mater, usually first manifests its presence by *unilateral root pains*. These may persist for many years without other symptoms; but eventually evidences of unilateral compression of the cord follow (Brown-Séquard type of paralysis). When the tumor is situated on the anterior surface of the cord, progressive paraplegia may develop, and the root pains may be entirely absent or appear late in the course of the disease,—as in a case which I observed in conjunction with Dr. Fraenkel in the Montefiore Home. If the tumor is located posteriorly, the root pains may, from the first, have a bilateral distribution from pressure upon adjacent roots. If, however, it occupies a central position between the roots, a clinical picture of ataxic paraplegia may result from pressure upon the long tracts of the cord (Oppenheim). It is also of interest to know, that rarely the effects of pressure on the cord may be greatest on the side opposite the lesion.[9]

The pains which result from pressure upon the posterior roots are segmental in their distribution, and do not follow the course of the nerve trunks, as in true neuralgia, and the

tender points so characteristic of neuralgia are absent. When present, these segmental root pains are of the greatest value in determining the level of the lesion, and according to Bruns are to be referred to, *a compression of the segment from which the root springs, and not to pressure upon the root in its intraspinal course,* a clinical law which has an important bearing on localization. In central tumors (intramedullary) the root pains are either absent or comparatively insignificant, and this constitutes an important differential sign from the extramedullary growths. Exceptions are occasionally noted.

The clinical picture of intramedullary tumor resembles somewhat that of a subacute or chronic transverse myelitis. The tendency to extension of the symptoms in an upward direction is frequently observed, and is another distinguishing feature from growths without the cord. In extramedullary neoplasms, on the other hand, the course of the affection suggests that the tumor is growing in width, and not increasing in length,—a clinical fact emphasized by Oppenheim, and which I have had frequent opportunity to verify. In central tumors (gliosis and glioma), vasomotor and trophic disturbances are of frequent occurrence, as well as a spinal deformity without pain or tenderness (kypho-scoliosis). Very characteristic also is a homolateral dissociated anæsthesia of segmental distribution (posterior horn anæsthesia). In extramedullary growths, root pains and root anæsthesias are present on the side of the tumor, and a contralateral anæsthesia below the level of the lesion. A dissociated anæsthesia (loss of pain and temperature sense) cannot be regarded as characteristic of central tumors, and may be encountered in vertebral and extramedullary localizations as well. *I have observed, however, that the tactile sense, under these circumstances while present, is definitely obtunded when compared with a normal area, which in some cases serves to separate this form of sensory disturbance from the dissociated anæsthesia of the syringo-myelic type.*

Atrophic palsies occur both in central tumors with invasion of the anterior horns and in eccentric growths involving the

anterior roots, although atrophy dependent upon extensive longitudinal involvement of the cord and accompanied by fibrillary twitchings is very characteristic of the central tumors, especially if associated with a loss of pain and temperature sense, homolateral and of segmental distribution. Fibrillary twitchings may, however, accompany extradural tumors situated on the posterior aspect of the cord, as occurred in several of my cases.

Symptoms resulting from an extensive longitudinal involvement of the cord are usually indicative of central tumors (an exception is the diffuse sarcomatous infiltration of the meninges). *In this connection I desire to emphasize a symptom which I have repeatedly observed in cases of extramedullary tumor in the cervical region. This consists of a distinct girdle sensation, or constriction, situated at the umbilical level or in the lower thoracic zones.* A similar observation has been recorded by Lenander and Henschen.[10] In all of my cases in which this symptom was present, it disappeared after the removal of the growth. I have also observed an abdominal girdle sensation complicating a central tumor of the upper cervical region, which disappeared after the evacuation of cystic fluid from the interior of the cord.

The presence of a girdle sensation in cervical tumor, both extra- and intramedullary, is in all probability caused by pressure and irritation of intraspinal tracts. They are of the same nature as the referred pains sometimes observed in the lower extremities, from irritation of sensory tracts by tumors situated in the higher levels of the cord. It is of importance that their occurrence in tumors of this region should be recognized, otherwise they may be assumed to indicate a much greater longitudinal invasion of the cord than really exists.

Localization in the Long Axis of the Cord.—In determining the level of the growth for purposes of laminectomy, I consider the initial root pains when present to be of the first importance.

These are usually so persistent and severe, that even if the

patient first comes under observation long after their disappearance, their original seat may, as a rule, be determined with certainty.

When pain is absent, other localizing signs must be depended upon, such as muscular atrophy, paræsthesia, and the upper level of objective sensory disturbances.

The disappearance of root pains, which have existed for a considerable time, is usually caused by degenerative atrophy of the compressed roots; in which event a radicular strip or patch of anæsthesia or hypæsthesia may usually be demonstrated. In this connection it is well to remember Sherrington's law of the overlapping of sensory distributions, so that two or more roots must suffer compression in order to produce a demonstrable objective sensory disturbance.

I have already spoken of Brun's law, which refers a root pain from tumor compression to the segment from which the root arises and not to the root, in its intraspinal course.

Hyperæsthesia may, however, be caused by irritation of the root, which arises from the segment just above the growth.

Symptoms indicating involvement of the anterior roots, such as atrophic palsies of the extremities, are also important as localizing signs, either alone or as more frequently happens in combination with posterior root symptoms. In tumors of the lower dorsal region there may be localized palsies of the abdominal wall with reaction of degeneration and dislocation of the umbilicus from the median line. With the onset of medullary compression, the highest level of the objective sensory disturbance becomes a very important sign, and in this connection a diminution of sensation (hypæsthesia and hypalgesia) is as significant as a more complete sensory loss.

When present, a definite area of spinal tenderness or deformity are most important as localizing factors, but should always, I believe, be considered in their relation to the purely neural symptoms, otherwise deception may result. I have more than once observed local tenderness and slight deformity in a region of the spine when the root and medullary symptoms clearly indicated a different level of the cord, and which was subsequently confirmed.

The percussion note is, in my experience, without value; it should, however, always be tested and may be of assistance.

The abolition of the tendon and skin reflexes is also important, but only in conjunction with other symptoms.

I have not found it of any great practical importance to determine the lower pole of the tumor; this is often difficult or impossible, as the compression of the cord above usually masks the root symptoms at a lower level. The eccentric or referred pains due to irritation of the intraspinal sensory tracts are of no localizing value, and unless their true nature is realized may give rise to error. The same is true of the girdle sensations, which I have observed so frequently at the waist level in intraspinal tumors of the cervical region.

REPORTS OF CASES.

CASE I.—Extramedullary tumor (endothelioma) of the lower cervical segments, with successful extirpation.

CASE II.—Extramedullary tumor (fibrosarcoma) at the eighth cervical and first dorsal segments, with successful extirpation.

CASE III.—Extradural tumor (fibrosarcoma) of the upper cervical region (second, third, and fourth cervical segments). Extirpation, followed by recurrence and second operation which was successful.

CASE IV.—Extramedullary tumor (fibrosarcoma) of the lower cervical and upper dorsal segments. Extirpation, patient dying three days after the operative procedure.

CASE V.—Extramedullary tumor (fibrosarcoma) at the tenth dorsal segment, with successful extirpation.

CASE VI.—Extramedullary tumor (fibrosarcoma) of the lumbosacral region. Extirpation, with relief of pain but recurrence of tumor within a year.

CASE VII.—Extramedullary tumor (neurofibroma) at the cervical segment; with autopsy.

CASE VIII.—Intramedullary tumor of the upper cervical region, with exploratory operation and evacuation of two drachms of cystic fluid from the interior of the cord.

CASE IX.—Intramedullary tumor in the cervical region, with exploratory laminectomy. Growth inoperable.

CASE X.—Sarcoma of the meninges in the upper dorsal region, with exploratory laminectomy. Inoperable growth.

CASE XI.—Sarcoma of the meninges in the lumbar region, with autopsy. Inoperable growth.

CASE XII.—Carcinoma of the spine, with compression of the spinal cord at the twelfth dorsal segment: exploratory operation.

CASE XIII.—Melanoma of the sacrum, with compression of the corda equina: exploratory operation.

CASE I (Summary).—*Extramedullary tumor of lower cervical segments successfully removed. Onset with pains in the back of the neck and left shoulder, later in the right. Duration of pains one year, followed by flaccid paralysis of the left arm, spastic paralysis of the left leg and dissociated anæsthesia of the opposite side below the level of the third rib. Pathological diagnosis of tumor, endothelioma. Nearly complete restoration of function. No recurrence after 7 years.*

History.—Mrs. S., aged thirty-one, married; no children, no miscarriages. A few months before the onset of present trouble she fell and injured right hip. In October, 1901, was seized with pains in back of neck, later extending into left shoulder, which were very severe and sometimes lancinating. Later the pains were also felt in right shoulder. Six months after the initial pains, sharp lancinations also felt in upper chest below clavicles. One year after pains had made their appearance the left arm became weak and the left leg stiff and awkward. These symptoms progressed gradually and she soon noticed that the right leg was insensitive to heat and cold. Of late there has been a disturbance of the vesical sphincter and a girdle sensation immediately above the umbilical level. She also has had paræsthesias of both arms, more marked in the left. She states that several months previously the neck had been quite stiff for a time and movements had increased the pain. This, however, disappeared and has not recurred since.

Examination (January 23, 1903).—The cranial nerves are normal. The pupils are equal and react normally. Movements of the neck are free. There is no abnormality of the spinal column. Sitting up and bending the head forward accentuates the girdle sensation at the umbilical level. Jarring of spine and deep pressure cause no pain. The paralysis of the left upper extremity is distributed as follows. There are normal movements

of abduction, external and internal rotation of the shoulder and of flexion and supination of the elbow. Adduction of the shoulder is diminished and there is paralysis of the movements of extension of the elbow, pronation, extension of the thumb and fingers, flexion of the wrist and fingers (with the exception of the flexor sublimis digitorum, which is weak) and of the intrinsic muscles of the hand. There is well marked atrophy of the paralyzed muscles, but no fibrillary twitchings. The circumference of the left arm and forearm is half an inch less than on the right side. No oculopupillary symptoms.

Sensations.—On the entire right side below the level of the third rib anteriorly and the fourth dorsal spine posteriorly there is complete loss of pain and temperature sense, with preservation of the tactile sensibility (dissociated anæsthesia). Corresponding to the upper limit of this anæsthesia there is a hyperæsthetic band which is present on both sides of the trunk. There is a slight but distinct tactile disturbance along the inner side of the left arm and forearm. The deep sensibility of the fingers of the left hand is absent, but in the lower extremities the articular sense of the toes is preserved. The tendon reflexes of the lower extremities are exaggerated, more especially on the left side, which is spastic and in which ankle clonus is present. Babinski reflex present on both sides.

Surgical History.—She was referred for operation by Dr. Joseph Fraenkel of this city who diagnosed and localized the tumor. The operation was performed February 2, 1903, under ether anæsthesia, with the patient in a prone Sims' position on the left side. The spines and laminæ of the fourth to the seventh (inclusive) cervical vertebræ were removed by bone cutting forceps and a rongeur respectively. There was absence of pulsation in the lower part of the dura exposed. Median incision of the dura. Gauze was inserted between the dura and the cord at the cranial side of the opening which checked the troublesome flow of cerebrospinal fluid. At first nothing was seen except some bulging of the cord opposite the sixth lamina. Here a probe encountered resistance on the left side, where, pressing the cord to the right, a dark bluish prominence was seen anterior to the posterior nerve roots and extending anteriorly. Two posterior nerve roots were cut central to the root ganglia to expose the tumor. After dividing its capsule along the curved

line where it was apparently continuous with the pia, the tumor was fairly easily removed by blunt dissection. The tumor was apparently attached at one point to the pia. It measured 2 cm. in length by 1¾ cm. in width and 1¼ cm. in thickness. The dura was sutured with fine gut, the muscles and aponeurosis with chromic gut and the skin with silk. A cigarette drain was inserted to the dura at the lower angle which was removed two days later.

Postoperative History.—After operation the paralysis of the left side was somewhat increased, and there was some weakness of the right side, which cleared up in about ten days. She complained of paræsthesia (prickling), particularly in the upper extremities, and profuse perspiration of the face and neck was very annoying. Healing occurred *per primam.* There was no improvement for two weeks except the disappearance of the paræsthesia and sweating, and the immediate disappearance of the root pains.

On March 23, 1903, there was no demonstrable anæsthesia corresponding to the posterior roots severed at the time of operation; there had, however, been some paræsthesia which had practically disappeared. Since then steady improvement for a year or two. Motion returned first in the right and then in the left leg. Six years after the operation there remained only a slight weakness of the left hand. The tumor was an endothelioma (Prof. Ewing).

Remarks on Diagnosis and Localization.—The diagnosis of tumor was based upon the onset with lancinating pains, at first unilateral, and always more severe upon the left side, atrophic paralysis of the muscles of the left arm (lower arm type), and the symptoms of progressive unilateral compression of the cord (Brown-Séquard type). The absence of rigidity and tenderness of the spine was in favor of an intradural growth. Of especial interest was the presence of a well-defined dissociated anæsthesia upon the right side of the body below the level of the lesion, which gave rise to some uncertainty as to the intra- or extramedullary seat of the growth. It is possible that the localization of the tumor on the lateral

surface of the cord in this case by pressure upon Gowers's tract was responsible for the dissociation of sensibility. The duration and severity of the root pains preceding the compression of the cord were in favor of extramedullary growth. Of especial interest was the presence of a girdle sensation at the umbilical level. This association Dr. Fraenkel and I had observed previously in a case of extramedullary tumor on the anterior surface of the cord in the cervical region, so that we were rather inclined to regard it in this case as possessing some significance as an extramedullary symptom. Since then, I have observed this symptom in central tumor in the cervical region. The atrophic paralysis of the arm was attributed to compression of the anterior roots of the sixth, seventh, and eighth cervical, and first dorsal segments. It is interesting to note that oculopupillary symptoms were absent, although the intrinsic muscles of the hands were paralyzed and tactile disturbances were present along the inner side of the arm.

Case II (Summary).—*Extramedullary tumor at the eighth cervical and first dorsal segments, successfully removed. Onset with pains in the back of the neck, the upper portion of the chest and the inner side of the right arm, followed seven years later by similar pains in the corresponding distribution on the left side. Duration of root pains before the appearance of spinal cord compression about ten years. These consisted of weakness of right hand and forearm with atrophy, spastic paralysis of the right leg, and tactile, pain and temperature disturbances below the level of the third rib, more marked on the left side. Pathological diagnosis—fibrosarcoma. Partial restoration of function. No recurrence after five and one-half years.*

History.—Mr. W. M., age forty-five, manufacturer, single, was admitted to the Presbyterian Hospital September 6, 1904. He is a man of moderate habits. No history of venereal disease or trauma. The present illness began twelve years ago with neuralgic pains in the upper portion of the right side of the chest, just below the clavicle, and along the inner side of the right arm. These pains continued with varying intermissions up to the present time. They are described as intensely neuralgic, somewhat like a toothache in character. Seven years later

pains of the same character made their appearance along the inner side of the left arm, as well as the upper portion of the left side of the chest. During this entire time there were no paræsthesia and no weakness of the arms, and he was treated for rheumatism and neuralgia without success. When the pains appeared upon the left side their intensity diminished somewhat on the right. They were often of a throbbing character. For the past year he has had a girdle sensation below the margin of the ribs, and for the same length of time has been impotent and very constipated. He has had a weakness of the vesical sphincter for the past six months and some uncertainty of the rectal sphincter. The girdle sensation is one of a feeling of pressure which comes on at night but has usually disappeared by morning after sleeping. It is increased in the sitting posture and disappears when standing or walking. In July, 1903, while in swimming he noticed that the right leg felt heavy and a little stiff, and this has been growing progressively worse. Occasionally he has paræsthesia of the feet, more especially of the right. He says that during the past week the neck has occasionally felt somewhat sore and stiff. This he had not noticed previously.

Examination (August 18, 1904).—Patient can stand and walk, but he drags the right leg which is distinctly spastic; and there is a marked Romberg symptom. Cranial nerves are normal. Pupils are equal and reactions present. The movements of the neck are quite free and cause no pain. There is no tenderness on jarring or direct pressure along the spine. There is a distinct weakness of the flexors and extensors of the right forearm, with slight atrophy along the ulnar sides of both forearms and in the intrinsic muscles of the right hand. Fibrillary twitchings are present in the intrinsic muscles of the hands, inner side of the forearms and the extensors of the forearms and triceps.

Sensations.—The tactile sense is practically abolished below the third rib anteriorly and the fourth dorsal spine posteriorly, as well as along the ulnar sides of the forearms. The pain and temperature sense are very much diminished below the nipples, more especially of the left leg. The deep sensibility of the right lower extremity is very much disturbed. There is a loss of pain and temperature sense along the inner side of the right

arm and forearm and a diminution of the pain sense along the inner side of the left arm. There is slight obtunding of the tactile sense along the ulnar sides of both hands. No hyperæsthesia. There is no ataxia of the upper extremities and the arm jerks are present. The abdominal and cremasteric reflexes are absent. The electrical responses in the intrinsic muscles in the hands and in the forearm to both faradic and galvanic currents are practically normal. The right lower extremity is weak in all segments. In the left there is good power but weaker than normal. The tendon reflexes are exaggerated on both sides, more especially the right. Ankle clonus and Babinski are present on both sides.

Surgical History.—Operation September 7, 1904. Anæsthesia, gas and ether. In a prone Sims' position on the left side, a median incision was made from the second thoracic to about the fourth cervical spine. The spines and laminæ of the sixth and seventh cervical and the first dorsal vertebræ were removed. The dura did not pulsate and appeared swollen. There was no spurting of the cerebrospinal fluid until the incision had been carried above the swollen area. On opening the dura, an area firmer and darker than normal was disclosed beneath the seventh lamina. After dividing many layers of arachnoid and a thin bridge of what appeared to be nerve tissue, a cystic cavity was opened disclosing in it a tumor on the right posterior aspect of the cord, extending down beneath the first thoracic lamina. On removal by blunt dissection it measured 3.7 cm. long by 12 x 6 mm. broad. The wound was closed and drained as in Case I.

Postoperative History.—The sutures were removed on eighth day, primary union. Not long afterwards the skin opened up down to the fascia. A few days after the operation there was a free discharge of clear cerebrospinal fluid from the site of the drain until it was checked by the pressure of a pad. It ceased after eighteen days. For the first twenty-four hours the patient was not on an air bed, and notwithstanding the shortness of this period a shallow bed-sore subsequently developed over the sacrum and on each heel in spite of careful nursing. After operation the power of the right leg was completely lost; that of the left leg partly so, and the arms were very weak. The paralysis gradually cleared up so that by the end of the third week the arms were freely movable, though the legs improved more slowly.

There was also pain and painful twitchings in the legs and arms, which lasted between two and three weeks, gradually diminishing. September 10 there was sensitiveness to noises and light and distinct oculopupillary symptoms in the right eye. He was catheterized for the first week. There was no increase of the anæsthesia. Much of the time for the first week he was irrational and delirious. A week after operation he was free from root pains. A peripheral peroneal palsy of the left leg was discovered, due to pressure on the operating table or during the early postoperative period when he was paralyzed. The improvement in the lower extremities was slow and steady, and the peroneal paralysis cleared up. He regained sphincteric control. Five years after operation (1909) there is no sign of recurrence, he has no pain and walks with a cane. The right leg is weak and spastic. The microscopic diagnosis of the tumor was "fibrosarcoma, vessels fairly numerous" (Path. Lab. Presbyterian Hospital).

Remarks on Symptomatology.—This case is of unusual interest because of the long duration (ten years) of the posterior root pains. For seven years neuralgic pains were confined to the inner side of the right arm and the upper segments of the right side of the chest, without any weakness or numbness of the extremity. As the pains appeared upon the left side in a corresponding distribution, they diminished in intensity on the right side. This diminution was evidently due to destruction of the root fibres, as objective sensory disturbances were demonstrable along the inner side of the arm. The symptoms of cord compression appeared after ten years of neuralgic pains, and were predominant upon the right side, as was evidenced by the greater weakness and spasticity of the right leg and loss of the deep sensibility of the lower extremity, and the greater anæsthesia upon the opposite side of the body. That fibrillary twitchings in the muscles of the right hand and forearm may be present in extramedullary tumor situated on the posterolateral aspect of the cord, is interesting as it might give rise to uncertainty in regard to the seat of the growth. Twitchings of this character are commonly associ-

ated with irritation and degeneration of the anterior horn cells of the spinal cord, and are therefore a common symptom in central tumors. It is possible that the long duration of pain in this case may reflexly have induced an irritable state of the anterior horn cells, with consequent fibrillations. The atrophy which was present shows, however, that the anterior roots must also have suffered from pressure. In this case also a girdle sensation was present in the lower thoracic zones, which disappeared after extirpation of the tumor. This sensory symptom, referable to a much lower level than that of the lesion itself, is in all probability an eccentric or referred sensory symptom from irritation of intraspinal tracts. Although the first dorsal segment of the cord was the seat of compression, oculopupillary symptoms were not observed until after the operative procedure.

CASE III (Summary).—*Extramedullary tumor of the cervical region (third, fourth, and fifth segments). Operation in two stages. Successful removal of tumor mass. Recurrence in ten months. Second operation with removal of growth, followed by recovery with fair restoration of function. No recurrence after four and a half years. Symptomatology consisted of pains in the neck and shoulders with rigidity, followed two years later by symptoms of compression of cord, paralyses of the arms and legs and mild sensory disturbances. Pathological diagnosis—fibrosarcoma.*

Mrs. C. C., aged thirty-one, was admitted to the Presbyterian Hospital Oct. 27, 1904. She was a patient of Dr. Max Mailhouse, of New Haven, Conn., whose diagnosis and localization of the tumor was confirmed by Dr. C. L. Dana who saw her in consultation. She has had one child, no miscarriages. No history of trauma.

History.—In January, 1902, she was seized with pains in the back of the neck, radiating into the left shoulder. This pain was severe but not constant and during the paroxysms the head would be drawn down toward the left shoulder, assuming somewhat the attitude in wry neck. These pains would come and go, sometimes lasting two or three months, then disappearing for a time, the longest interval having been three months. Even

during this time she was conscious of slight pain in the post-cervical region. She had no pain anteriorly in the cervical region and none in the arms. In January, 1904, there developed numbness in the fingers which gradually passed up the inner side of the left arm. This was soon followed by a weakness in the left hand and shoulder. In March, 1904, the left leg became weak and stiff and has been getting gradually worse. The right leg is also weak, but much less so than the left. At night she is subject to spasmodic contractions of the muscles of the arms and legs. Sometimes all four extremities contract simultaneously and are drawn up together in a flexion attitude. In September, 1904, she experienced difficulty in micturition and for the past few days catheterization is necessary. In August the numbness appeared in the fingers of the right hand. This also was followed by weakness, especially in the movements of the shoulder. Since June, 1904, there is a girdle sensation in the epigastric region, which is constant. There is a transient girdle sensation around the breast, and rarely around the hips. The epigastric girdle is accentuated in the recumbent posture and on standing. It is also increased on turning the head toward the extreme right.

Examination (October 29, 1904).—Cranial nerves are normal. The left pupil is somewhat wider than the right but the reactions are normal. There is no ptosis and no enophthalmos. There is well marked rigidity of the posterior muscles of the neck so that the head cannot be brought forward. Movements of the head to the right are also restricted owing to the rigidity, not however toward the left. Backward movements are free. The left upper extremity, except for slight movements in the index finger, is practically powerless. In the right arm slight movement is possible in all segments, but the power is very much diminished. The excursions of the intercostal movement are also diminished. The diaphragmatic breathing is normal. Both lower extremities are paretic, especially the left, which is spastic with ankle clonus. The Babinski reflex is present on both sides. The epigastric reflexes are absent.

Sensation.—The tactile sensation is slightly disturbed over both upper extremities and the trunk, below the fourth dorsal spine, although no definite areas of anæsthesia can be made out. There is, however, an anæsthetic patch posteriorly over the upper portion of the left scapula. Pain and temperature sense are well

preserved over the arms, trunk and lower extremities. There is a band of hyperæsthesia on a level with the clavicles and another on a level with the nipples. Except for the rigidity and some tenderness on pressure of the neck, no abnormality of the spinal column could be detected.

The general condition was poor, the patient having eaten very little for the past few weeks. The diagnosis was made of an extradural tumor at the sixth and seventh cervical segments.

Surgical History.—Operation October 29, 1904, under gas and ether anæsthesia. The spines and laminæ of the fourth, fifth, and sixth cervical vertebræ were removed, exposing an oval extradural, encapsulated tumor 3 x 1.5 cm., on the left postero-lateral aspect of the dura, opposite the fourth lamina and extending up under the third. The capsule, very adherent to the theca, was opened, disclosing an enucleable tumor, but at this stage the pulse and then the respiration suddenly failed. Artificial respiration and the intravenous infusion of 1000 c.c. of normal salt solution were employed and the patient reacted well to stimulation. The wound was temporarily packed and brought together by a few sutures. Stimulating and nutritive enemata for the next forty-two hours brought the patient into better condition than before the operation.

October 31 the operation was completed. The wound was reopened, part of the third cervical lamina was removed, and the tumor was removed piecemeal by blunt and sharp dissection. The oozing of blood was troublesome and was controlled by hot packing. The tumor seemed to spring from the dura in which a small opening was made, where the capsule was most adherent to it. This was closed by catgut suture. Wound closed as in previous cases. The condition of the patient remained good throughout the operation.

Postoperative History.—About the second day after the last operation she began to move the left hand. Power of motion improved rapidly and by the fourth day, motion, except in the left upper extremity, was nearly normal. By the fourteenth day, when she left the hospital, motion was normal except in the left upper extremity in which all but the finer movements were performed slowly. Pain in the extremities and sudden sharp pain in the wound was severe at first, but on the fourth day after operation it began to diminish, and was practically gone by the

thirteenth day. Urination was involuntary for a few days after operation and catheterization was employed. There were no oculopupillary symptoms (the left pupil is still a little wider than the right). The wound healed primarily. She made a practically complete recovery. The tumor was a fibrosarcoma.

A short time after her discharge from the hospital, November 13, 1904, she was practically well, except for stiffness in the left shoulder, and in January, 1905, the adhesions were broken up under anæsthesia and the arm restored almost to normal. There was no pain except occasional darts up and down the neck. Some stiffness of the neck always persisted.

In August, 1905, the first symptoms of recurrence appeared, consisting of pains in the neck and an aching pain in both hands. This was soon followed by weakness of both arms and legs, which gradually progressed. The girdle sensation in the lower thoracic zone reappeared. The symptoms have been symmetrical from the first and gradually progressive.

Examination (October 20, 1905).—Patient can stand and walk without assistance. The arms are weak in all segments, the right more than the left. Movements of the neck are somewhat restricted by rigidity. No ataxia of the arms. Tendon reflexes of the upper and lower extremities are all exaggerated. There is patella clonus on both sides, no ankle clonus. Babinski reflex on both sides. Abdominal reflexes faintly present. Superficial sensations of the trunk and extremities are normal, as well as the deep sensibility of the lower extremities. Pupils are equal. No vesical disturbances. There is a tender point about one and a half inches above the vertebra prominens. The general condition is far better than it was a year ago.

Surgical History.—Operation October 27, 1905, under gas and ether anæsthesia. Incision to the side of the old scar. The seventh cervical laminæ were removed to determine the level of the dura, which was covered by scar tissue above. The latter was readily separated from the dura to the upper end of the old laminectomy opening. The cord appeared flattened on the left side and on careful dissection a tumor 5 x 2 cm. was exposed on the left lateral aspect of the cord. This was removed piecemeal. It was well encapsulated, at least in part, and the capsule on the side toward the dura was removed cleanly, with a resulting

tear of the dura, which allowed the escape of considerable cerebrospinal fluid and was sutured. The tumor filled the left half of the canal extending out into two or more intervertebral foraminæ, where it was uncertain whether the tumor was entirely removed. Two or three nerve roots were exposed in the dissection but were apparently uninvolved and unharmed, though superficially scraped. The tumor extended no higher than before but somewhat lower. Wound closure as before, except that several silkworm gut retention sutures were employed, to be left in twelve to fourteen days to avoid the opening up of the wound as in Cases II and V. There was some postoperative shock but she responded to stimulation.

Postoperative History.—There was considerable paralysis of all extremities after operation. She soon began to move the right leg and a little later all the extremities, but recovery was much slower than after the first operation. Considerable pain was complained of in the legs and some in the neck. She sat up November 10, and went home November 12, when both lower extremities were moved well, the right arm was moved freely but was weak, while there was only slight motion in the left arm, which, however, was steadily but slowly improving. The microscopic diagnosis was the same as before, fibrosarcoma.

February 3, 1906: Recovery has been very slow, but has been more noticeable the past two weeks. She can walk with some assistance. The left side is still very weak and she has not yet regained the use of the left hand.

May 23, 1906: The gait has improved so that she walks very well, and can even stand on the left foot alone. There is still ankle-clonus and exaggerated knee jerks on both sides. The left arm remains spastic and paretic with flexion of the fingers, and she can do little with the left hand. No evidence of recurrence as yet. In view of the first recurrence, a bad prognosis was given, but in this we were wrong, for on November 3, 1909, four years after the second operation, Dr. Mailhouse writes, "Mrs. C. is practically well. She does her own housework and marketing, and goes out daily. She still presents evidence of the degeneration of the pyramidal tracts, produced by the long duration of the disease prior to operation, in a spastic condition of the left arm and leg and carries her head stiffly."

Remarks on Symptomatology.—In this case root pains preceded the onset of symptoms indicating medullary compression, by a period of two years. The pains were in the nuchal region and were bilateral, and when severe, extended into the left shoulder. Very interesting and very suggestive of extradural growth was the accompanying rigidity of the posterior muscles of the neck and the wry-neck attitude during the paroxysms of pain. It will be observed that the backward movements of the head were unrestricted, and the lateral movements only in a slight degree, toward the right side. That this symptom may be entirely absent in extradural tumor of the cervical region, is shown conclusively by a case which I saw in consultation with Dr. David Bovaird in the Presbyterian Hospital, in which an epidural perithelioma was successfully removed by Dr. Joseph Blake.

There was slight tenderness on pressure over the cervical region, but much less than is usual in primary affections of the vertebral column. In this patient a girdle sensation in the epigastric region was observed, as well as transient sensations of constriction about the hips and across the breasts, probably due to irritation of intraspinal tracts.

CASE IV (Summary).—*Extramedullary tumor of the lower cervical and upper dorsal segments. Operation, removal of tumor; death after three days. Onset nine years ago. Without root pains. Gradually increasing paraplegia with sensory disturbances and loss of the sphincter control of the bladder and rectum. Pathological diagnosis—round-celled sarcoma.*

Mrs. R. A., aged forty-six, was admitted to the Presbyterian Hospital June 12, 1905. She was a patient of Dr. I. Abrahamson and was referred by Dr. C. L. Dana, who has seen her in consultation and confirmed the diagnosis. There was a history of a fall, striking on the vertebra prominens. One brother died of a brain tumor, thought to be due to a trauma.

History.—Nine years ago first noticed numbness and weakness in the ulnar distribution of the right hand and forearm, followed by weakness of the hand. These symptoms have pro-

gressed steadily but very slowly. Soon after noticed weakness of the vesical sphincter. Three years ago the right leg first became weak. Two years ago there were, for a time, sharp cutting pains in the right knee varying in intensity, not always present and not increased by use. Soon after this both legs became weak and the knees became stiff, making walking difficult, and finally impossible about nine months ago. For about six months she has had no control of urine, and for the past month no control of flatus. For the past three months, there has been a steady increasing pain in the right submammary region, and recently a girdle sensation, at first on the right and for the past week on both sides. Previous to this she had experienced no root pains.

Examination (June 12, 1905).—The muscles on the ulnar side of right hand and forearm are much weaker than the corresponding muscles on the left. Wasting of the interossei of right hand, less of left, with fibrillary twitchings. Ataxia of the right arm. Wrist and triceps jerks diminished on right, exaggerated on left. Motor power of the lower extremities much diminished, especially on right. Right leg more atrophied than the left. Right thigh and leg flexed, knee contractured, so that patient cannot walk. Knee and ankle clonus exaggerated on the left, but are less on the right (contractures). Babinski on both sides.

Sensation.—Sensibility is diminished along the inner side of the right arm and hand. On the right side from the jaw to the third rib diminished sensibility to touch, below this loss of tactile sensation. On the left side from the jaw to the clavicle there is hyperæsthesia, below this to fourth rib normal, from fourth to fifth ribs diminished sensibility and below this anæsthesia. Right side is anæsthetic to just above the knee, and on the left side to just above ankle. Posteriorly on the right above fourth dorsal spine, diminished sensation, below this anæsthesia; on the left down to the third dorsal spine hyperæsthesia, third to ninth normal, below this anæsthesia. The first dorsal spine is very tender on percussion; the seventh cervical spine is also tender but to a lesser degree.

No control of urine or flatus. Lately there has been pain in the right submammary region and a girdle sensation. The tumor was localized at the eighth cervical and first and second dorsal segments.

Surgical History.—Operation June 14, 1905, under gas and ether anæsthesia. Technic as in previous cases.

Operation.—The fifth, sixth, and seventh cervical and first dorsal spines and laminæ were removed and later most of the fourth cervical and second dorsal. Exposed dura tense and without pulsation. On opening it a small amount of clear fluid escaped as if under considerable pressure. This fluid came from a cyst overlying the tumor. The latter was elongated and lobulated and lay on the posterior surface of the cord, flattening it, between the upper margin of the fourth cervical and the lower margin of the second dorsal laminæ. The tumor was carefully dissected off the cord by blunt and sharp dissection. Wound closure as in previous cases. During the operation the pulse rose to 120 and there was some cyanosis as the respiration became feeble and irregular, and finally ceased, but it was quickly resumed. An infusion of 1250 c.c. of a 0.09 per cent. salt solution with adrenalin was given on the table. The operation was a long one, lasting over two hours, owing to the length of the tumor and the difficulty of its removal.

Postoperative History.—On recovery from anæsthesia she kept calling for air, but there was no cyanosis or dyspnœa. Two days later, breathing was more labored and on the following day, before death, there was cyanosis. Pain was complained of all over the body, and the patient was restless and at times irrational. The wound was dressed on the third day and a considerable amount of cerebrospinal fluid escaped on removal of the drain. In spite of stimulation the pulse and respiration failed and the patient died seventy hours after operation. During the last twenty-four hours the temperature rose, reaching 105, twelve hours before death, but there was no apparent infection. Microscopic diagnosis of tumor: round-celled sarcoma.

Remarks on Symptomatology.—This case is unusual in that the posterior root pains were absent, although the tumor lay on the posterior aspect of the cord and extended from the sixth cervical to the third dorsal segment. It was only in the later months of the disease, the history of which extended over a period of nine years, that lancinating pains were felt in the right mammary region, evidently corresponding to an irritation produced at the lower pole of the tumor. The clinical picture was ushered in by numbness and weakness of the right

upper extremity, and the early appearance of vesical symptoms. In this case also, as in Case II, fibrillary twitchings were noted in the atrophied muscles of the right hand. The sharp cutting pains in the right knee were probably eccentric in origin from irritation of intraspinal tracts. An abdominal girdle sensation was also present.

CASE V (Summary).—*Extramedullary tumor at the tenth dorsal segment. Successful removal with practically complete restoration of function. No recurrence after four and one-half years. Symptomatology consisted of localized root pain of seven years' duration, which was then followed by gradual compression of the cord, with spastic paraplegia and marked sensory disturbances. Pathological diagnosis: fibrosarcoma.*

History.—Mr. J. S., aged fifty-nine, married, was admitted to the Presbyterian Hospital August 14, 1905. No venereal disease. Trauma to knee and back below the left scapula three months before onset of symptoms. The present trouble began about seven or eight years ago with localized pain in the left side of the back and abdomen, corresponding to the level of the umbilicus. In the earlier years it occurred only at night and in the recumbent posture. It was more or less aching in character with occasional sharp darts. The pain was always unilateral and always limited to the same distribution. It has grown gradually worse during the past few years so that any sudden movement, and even a cough, is sufficient to bring it on. One year ago there appeared a numbness simultaneously in both great toes. This numbness gradually ascended the legs and thighs, eventually reaching the level of the umbilicus. He has also experienced sensations of burning and of cold in the lower extremities. Later there appeared ataxia and weakness of the lower extremities. He has a sensation of constriction in the region of the groins. No pain in the spine.

Examination (August 17, 1905).—Sexual power is diminished and there are slight vesical disturbances. Patient is unable to walk alone. There is a marked Romberg symptom. In the recumbent posture both legs present considerable ataxia. The gross motor power of the lower extremities is diminished, especially on the left side which is spastic, with ankle clonus and Babinski reflex. In the right lower extremity the knee jerk is exag-

gerated, there is pseudoclonus, no Babinski. Cremasteric reflexes are present and the abdominal reflexes at the level of the umbilicus are much exaggerated, especially on the left side. The umbilicus occupied a central position. The spine was not tender and the movements were free.

Sensations.—Below the level of the umbilicus all sensations are disturbed. The anæsthesia is almost complete in the distal portion of the extremities below the knees, very much diminished between the knees and the groin, and very definitely obtunded between the groin and the umbilicus. On the left side, corresponding to the third lumbar spine posteriorly and the umbilicus anteriorly, there is a well marked band of hyperæsthesia.

Surgical History.—Operation August 28, 1905, under gas and ether anæsthesia. Technic the same as in previous cases. The spines and laminæ of the eighth, ninth and tenth thoracic vertebræ were removed. The tumor, 2 x 1.5 cm., was exposed beneath the ninth lamina, surrounded by clear encysted fluid. It was situated posteriorly but somewhat more to the left, and shelled out easily after ligating and dividing a small vascular pedicle at either end. The wound was closed as in previous cases, save for a drain of three strands of catgut through the dura, on account of slight oozing from the veins of the cord.

Postoperative History (September 2).—Has complained of some pain in and above wound and at times he has been restless. Urination and defecation involuntary to-day for the first time. Drain removed; some watery discharge.

September 4: Sutures removed, primary union. Profuse watery discharge noticed on September 5 and on the following day the entire wound was found opened down to the fascia.

On September 7 his neck was retracted and stiff, he was restless and irrational and temperature and pulse had risen again (T. 103.5° on the sixth), after reaching normal. Discharge profuse, becoming more and more purulent, from the exposed granulating surfaces.

On September 9 there was marked tremor and muscular twitching over the entire body, and the patient was apathetic, restless and irrational.

September 14, the discharge has gradually diminished and the temperature fallen.

September 15, lumbar puncture withdrew one ounce of very

faintly turbid fluid which on culture gave non-pathogenic bacilli and cocci, perhaps due to contamination.

September 17, temperature normal. Since lumbar puncture patient has been quiet, more rational and without tremor.

September 19, again irrational. Lumbar puncture, withdrawing four ounces, with similar result. Culture showed saprophytes.

October 2, temperature remittent and when low patient is quiet and nearly rational; when high he is apathetic and has a marked tremor, most marked in the hands. The neck is still somewhat stiff. He has regained control of the rectum and bladder. The wound is nearly healed.

October 22, lumbar puncture, two ounces, fluid normal. Temperature normal and hereafter continued so. Knee jerks normal, no Babinski.

November 9, sat up in chair.

November 13, patient is clear mentally, more cheerful and stronger.

November 16, sensation in lower extremities normal except for muscular sense. Walked about fifty feet. Gait is ataxic. Left leg somewhat weaker than right. Reflexes slightly exaggerated; ankle clonus still present.

November 20, walks with one cane. Discharged improved. The tumor was a fibrosarcoma.

March 10, 1909: Three and one-half years after operation patient can now stand and walk well. No Romberg, no pains, and no paræsthesias. The vesical functions are normal. The left knee jerk is somewhat greater than the right. There is no clonus. The plantar reflexes are normal on both sides. The power of the left leg is somewhat diminished although its general strength is very fair. All qualities of sensations of the lower extremities are well preserved.

Remarks on Symptomatology.—The long history of unilateral root pains, of seven years' duration, limited to the tenth dorsal segment, followed by symptoms of spinal cord compression predominating on the left side, left little doubt as to the diagnosis of tumor and the extramedullary seat of the growth. The abdominal reflexes were greatly exaggerated at the umbilical level, especially on the side of the tumor.

CASE VI (Summary).—*Extramedullary tumor of the sacral region. Operation with successful removal of tumor. Relief of pain but little or no restitution of function. Probable recurrence about a year later. Symptomatology. Pain in the small of the back, left hip and left perianal region for three years, followed by weakness and sensory disturbances in the left lower extremity with loss of the sphincter control of the rectum and bladder. Pathological diagnosis: fibrosarcoma (glioma?).*

History.—Mr. F. N., aged fifty-eight, a manufacturer, was admitted to the Presbyterian Hospital November 13, 1906. He is a patient of Dr. S. A. Lewis, of Springfield, Mass., and was seen by Dr. C. L. Dana in consultation. No history of trauma and no positive venereal history. Present illness began in the summer of 1900 with pains in the small of the back, particularly on stooping and on movements of the spine. For three years pains remained about the same, after which they grew worse so that jarring or any sudden movement was quite painful. Pains are directly in the median line of the back and do not radiate into the sides. A few months later, pains developed in the left hip and gradually extended down the posterolateral aspect of the left thigh. These pains were very sharp and intense but varied considerably in their intensity. Pains were soon followed by numbness of the left thigh and external genitals, and to a less extent on the opposite side. The pain in the small of the back was the sole symptom for three years, and very soon after the pains appeared around the left hip and thigh there followed weakness in the lower extremities and some vesical disturbances. The pain is particularly distressing in the left scrotal and perineal regions and in the left gluteal fold. When a severe paroxysm of pain appears he finds the greatest relief in the upright posture. During these paroxysms the numbness appears over the right thigh. First he had difficulty of micturition and this was followed by incontinence. For the past year he has been unable to control either his urine or his fæces.

Examination (November 13, 1906).—Patient stands on the right leg, the left leg resting gently on the floor, slightly flexed at the knee. There is slight scoliosis. Bending movements of the spine are very fair, with perhaps a little stiffness in the lumbar region. There is no visible atrophy of the muscles of the legs or of the gluteal region. All movements of both lower

extremities are weak, but especially the left. This weakness is especially evident in the movements of the hip. Both knee jerks and both Achilles jerks are absent. The plantar reflexes are present but are diminished on the left. There is no Babinski. The spine is tender from the first to the fifth lumbar, more so over the third, fourth and fifth lumbar spines. There is no one spot of excessive tenderness. Rectal examination is negative. There is no Romberg symptom. He walks fairly well, but the left leg is not moved as freely as the right. The urine dribbles away constantly and is very turbid.

Sensations.—There is a well marked anæsthetic area over both buttocks, extending down the posterior surface of the thighs to about the knees, more marked on the left side. The sensations are also lost over the left hip and are diminished over the outer side of the left thigh, leg and foot. The scrotum, penis and perianal region are anæsthetic on the left side.

Surgical History.—Operation November 15, 1906, under gas and ether anæsthesia. Technic the same as in other cases. The spines and laminæ of the twelfth dorsal and first and second lumbar vertebræ were removed. Pulsation of dura not visible, but palpable. On opening dura, an elongated tumor, not attached to dura, was exposed extending from opposite the spine of the twelfth to nearly opposite that of second lumbar vertebra. Part of the eleventh dorsal and third lumbar laminæ had to be removed to insure complete removal of the tumor. The latter was situated posteriorly and was apparently composed of an upper smaller pinkish and a lower elongated yellowish-white cystic portion. Through the latter part passed two posterior nerve roots, which had to be divided in the removal of the tumor. A couple of small vessels from above required catgut ligature. Wound closed without drainage of dura and with reinforcing silkworm gut sutures.

Postoperative History.—He complained of much pain in the left ankle for the first two or three days. There was also considerable abdominal distress which disappeared only gradually. The urine and fæces were passed involuntarily.

Examination (December 5).—All pains have disappeared except around the anus and perineum, which is similar to that he felt before operation. The left leg is moved in all its segments, but is still considerably weaker than the right. Cremasteric

reflexes not elicitable. Plantar reflex still diminished on the left. The sensations of the entire left leg are practically abolished, including the deep sensibility. Sensation on the right side is normal with the exception of an area corresponding to the right side of the scrotum, penis and perianal region. The right knee jerk is active, the left is still absent. Both Achilles jerks absent.

Allowed to sit up after fourteenth day. December 12, has attempted to get about with walking machine and crutches. He is gaining slowly in control of left leg. There is an area of partial anæsthesia in the sole of the left foot extending up the inner side of the leg, also a saddle-shaped anæsthetic area involving the perineum and buttocks. Wound healed by primary union. Went home December 14, 1906. Pathological examination of tumor, fibrosarcoma (glioma cells probably), but neuroglia stain failed, perhaps due to delay in sending tumor to laboratory. A letter from Dr. S. A. Lewis of Springfield, dated November 9, 1909, says: "The only benefit derived from the operation was the relief from pain, which had been excruciating. There was no improvement in the paralysis or in the control of the sphincters. In the winter of 1907–08 (somewhat over one year after operation) the pains began to recur, with soreness, and it seemed to me the tumor might be recurring. In March, 1908, he was taken one day with severe vomiting, the next day he developed hemiplegia and coma, dying on the second day after. The urine was free from signs of nephritis at this time." There was no autopsy.

Remarks on Symptomatology.—The earliest symptom in this case was localized pain in the lower lumbar region, limited to the median line of the back. It is very probable that this pain was a symptom of meningeal irritation, as during this time there were no referred pains in the region of the perineum, hips, or lower extremities. After the lumbar pain had persisted for about three years, lancinations appeared in the distribution of the lumbosacral nerves on the left side, and were soon followed by paræsthesias, weakness of the extremities, and incontinence of the sphincters. The absence of both knee-jerks showed that the pressure effects on the cord extended as high as the third lumbar segment.

FIG. 1

Case VII. Extensive neurofibromatosis of the skin (Recklinghausen's disease), in a case with compression paraplegia from a neurofibroma at the fifth cervical segment.

FIG. 2.

Case VII. A solitary extradural neurofibroma at the fifth cervical segment in a case of Recklinghausen's disease. The dura mater has been cut away and the tumor left *in situ*.

CASE VII.—Patient was admitted to Bellevue Hospital on February 1, 1905, in the service of Dr. George Woolsey,[12] and was seen in consultation by Dr. Ramsay Hunt.

Summary.—Extradural tumor (neurofibroma) at the fifth cervical segment, complicating generalized dermal neurofibromatosis (Recklinghausen's disease); onset with lancinating pains in the shoulder, followed in six months by symptoms of compression of the spinal cord. Because of extreme weakness and emaciation, operation was impossible.

Family History.—Ten children, six of whom are dead; four died in early life, one brother the result of an accident, and one sister of heart disease. The other three children are living and well; all are married and have healthy children.

The patient was the sixth child and had always enjoyed excellent general health until the onset of the present trouble. He was always somewhat backward mentally, and solitary and peculiar in his disposition. He is of Irish extraction and his parents were not related.

There is no family history of tuberculosis, neuropathic tendencies, or of congenital marks or moles.

The patient is of unusually short stature, and as I have already stated, is backward mentally. He is shy and very easily frightened; has never had friends, and never learned to read or write. He is not alcoholic, but has smoked cigarettes to excess. For the past sixteen years he has worked in a wood-yard, earning $5.00 a week. He is good natured, and is not subject to outbursts of temper.

The multiple fibromata of the skin, which now cover the surface of his body, first manifested themselves about the fourth year, and have been steadily increasing in size and number ever since. He has never had any pain in them, and his mother is quite certain that they were not present at birth (see Fig. 1).

History of the Present Illness.—Present illness began one year ago, with pains in the left shoulder and left leg. The pain in the shoulder was sharp and lancinating in character, and was soon followed by sensations of pins and needles in the left upper extremity. Six months later, there was weakness of the left arm and soon after the left leg became similarly affected. These symptoms of weakness on the left side increased gradually, and were followed in the course of two months by weakness of the

right leg, when vesical symptoms also made their appearance. There has been a steady progression of the paralysis, with loss of sensation, complete incontinence of the sphincters, and the development of extensive bed-sores.

Examination (February 1, 1905).—Patient is of small stature, and very fragile skeletal development, except the head which is large and square. There is an extraordinary development of neurofibromatosis nodules of the skin, covering the face, trunk, back, and arms. They vary in size from a pin to a cherry. The pupils and cranial nerves are normal. Movements of the neck are free. No deformity or tenderness of the spine. The motor power of the left arm is almost abolished; external and internal rotation of the shoulder are, however, still present, but are very weak. Abduction and adduction are barely indicated by muscular contractions. There is also slight flexion of the elbow, which includes the supinator longus, but the paralysis of the extensors of the elbow and of the muscles of the wrist and fingers is complete.

In the right arm, movements of the shoulder, as well as flexion of the elbow, are preserved but weak; but there is a complete paralysis of the extensors of the elbow and of the muscles of the wrist and fingers.

The musculature of both hands and forearms is atrophic, but no fibrillary twitchings are observed. Breathing is purely diaphragmatic.

The left leg is paralyzed, with the exception of slight flexion of the left knee. The right leg is also paralyzed, save for flexion movements of the leg and weak flexion and extension of the foot.

Both legs are fixed in a flexed position and the knee-jerks are not elicitable (possibly because of the extreme flexion contracture). The left Achilles-jerk is present, but there is no clonus. On the right side, ankle clonus is present. Babinski's reflex is present on both sides. Abdominal reflexes are absent.

Shockingly large deep bed-sores are present over both hips and the sacrum, exposing the bony structure in all three localities, and discharging freely.

Careful examination of the peripheral nerves accessible to palpation fail to reveal any nodulations or varicosities, although the nerve-trunks themselves seem hard and thickened.

Sensations were somewhat difficult to test, because of the

mental state of the patient and his deplorable condition. There was, however, complete absence of pain, temperature, and tactile sensation as high as the third rib, anteriorly. There were also paræsthesias in the upper extremities, and the tactile sense was blunted, but the exact area on the arms could not be demarcated.

Note.—While the diagnosis, neurofibroma in the cervical region compressing the spinal cord, seemed reasonable, the condition of the patient precluded any attempt at operation.

In spite of careful nursing and care, the patient died on March 4, 1905. Permission was obtained to remove only the spinal cord and a few of the skin tumors, so that the condition of the brain and cranial nerves and the peripheral nerve-trunks could not be ascertained. A few of the posterior ganglia were removed with the spinal cord, but these were not enlarged.

At the level of the fifth cervical segment, a small rounded tumor the size of a hazel-nut was found outside the dura, at the junction of the anterior and posterior roots. It was pearly white in color and was encapsulated. On removing the dura, it was found that the tumor fitted into a depression on the anterolateral surface of the cord. Passing into the tumor was the anterior root of the fifth cervical nerve, the posterior roots passing over the surface of the tumor and being lost in its capsule. All the other nerve-roots were normal to the naked eye and presented no swellings or varicosities (see Fig. 2).

Histological Examination.—The spinal cord examined at various levels showed the typical secondary degenerations, above and below the level of the lesion,—more marked upon the left side. There were no evidences of neurofibromatosis in the nerve-roots or in the strands of the cauda equina.

Remarks.—This case is recorded because of the comparative rarity of the pathological lesions, and as an illustration of the diagnostic importance of cutaneous fibromata when associated with symptoms referable to the spinal cord. The tumor was correctly localized, and could have been removed with ease by an operative procedure had the general condition of the patient justified it. The small stature and low grade of mental development which were present have occasionally been noted in Recklinghausen's disease.

Histological examination of the spinal cord, including its roots, the cauda equina, and several spinal ganglia, fail to reveal any evidences of neurofibromatosis, with the exception of the tumor which had compressed the fifth cervical segment. So far, therefore, as the spinal axis is concerned, it was a solitary manifestation of the neurofibromatosis. Unfortunately, the brain and peripheral nerves were not available for examination. A solitary neurofibroma of the spinal axis as a complication of a generalized dermal neurofibromatosis may occur, but usually the tumors are multiple and are associated with varicose thickenings and nodosities of the nerve-roots. A case of this description I have already reported in detail,[13]—one in which an intravertebral neurofibroma in the cervical region had produced a complete destruction of the cord. In addition to this single large growth, all of the anterior and posterior roots in the cervical region were the seats of nodular tumor formation, and many of the spinal ganglia were similarly involved. There was also extensive neurofibromatosis of the peripheral nerve-trunks, and a large plexiform neuroma was situated in the subcutaneous tissues of the lower abdominal region.

Case VIII (Summary).—*Intramedullary tumor of the upper cervical region, fourteen years' duration. Onset with pain, lasting three years, followed by progressive spastic paralysis of the left arm and leg, and a contralateral anæsthesia (Brown-Séquard paralysis); slow progression of symptoms, with gradually increasing weakness of the left side, and ataxia and anæsthesia of the right.*

Exploratory Operation.—Third, fourth, and fifth cervical laminæ removed. Cord normal but somewhat swollen Evacuation of two drachms of cystic fluid from the interior of the cord on its posterior aspect.

[Referred to Dr. Ramsay Hunt by Dr. H. S. Paterson, of New York.] Woman, aged thirty-six, nurse-maid by occupation. No history of injury.

History (October 17, 1907).—Her present illness dates back twelve years and began with shooting pains in the posterior

aspect of the left shoulder. In the course of a few months, similar pains appeared in the corresponding region of the right side, but they were never quite so severe as on the left side. These pains lasted in all about three years, with occasional intermissions and varying considerably in their intensity. They gradually subsided and finally disappeared; during this time she was treated for rheumatism.

Soon after the pain in the shoulders appeared, she had pains in the knees on both sides, lasting for several months, which were of the same sharp and shooting character.

Nine years ago, *i.e.*, about three years after the onset of the shoulder pains, the left arm became weak, and a little later the left leg was similarly affected. The paresis of the left arm and leg has gradually increased, more especially during the past year, and is accompanied by increasing stiffness of the muscles.

For some years she has noticed that there is absence of perspiration on the left side of the body.

One year ago, numbness and prickling sensations were first noted in the right foot; these have gradually ascended the leg to the hip. In bathing, she has noticed that the right leg was less sensitive to heat than the left. A few weeks ago, the fingers of the right hand became numb. There have been no vesical symptoms at any time.

She has always been constipated, but more of late; there is no girdle sensation. She has no pain in the spine, and the left side of the body is quite free from paræsthesias.

Examination (October 17, 1907).—Station normal, but the gait is typically hemiplegic. There is a well-marked spastic paralysis of the left arm and leg, with exaggeration of the tendon reflexes and ankle clonus.

The tendon reflexes are also exaggerated on the right side, on which ankle clonus is also present. Babinski is present on both sides. The abdominal reflexes are absent. There is a slight atrophy of the muscles of the left shoulder, and distinct fibrillary twitchings are present in the left trapezius muscle, as well as in the second and third intercostal spaces on the left side.

The spine is mobile and absolutely free from any tenderness or rigidity. There is a distinct kyphoscoliosis in the cervical and upper dorsal regions, the convexity directed toward the left. The percussion note over the cervical region shows no dulness. The neck muscles on the left side are somewhat spastic.

Sensations.—The superficial sensations on the left side of the body are entirely normal, with the exception of the neck, where a zone of dissociated anæsthesia is intercalated between the lower margin of the jaw and the clavicle, anteriorly, and the lower occipital region and the spine of the scapula, posteriorly.

On the entire right side of the body there is a marked disturbance of sensation below the ramus of the jaw, anteriorly, and the occiput, posteriorly, involving the pain and temperature sensibility; tactile sensibility is also disturbed on the right side, but in a lesser degree, and chiefly over the distal portions of the extremities, *i.e.*, below the wrist and knee.

The deep sensibility of the hands is normal; there is no ataxia of the arms and the articular sense of the toes is undisturbed on both sides. Sensation of the face is normal.

Pupils are equal and react normally; no oculopupillary symptoms.

The probable diagnosis of a central gliosis of the spinal cord was made; as the patient was able to pursue her occupation as nurse-maid, and suffered no pain, an exploratory laminectomy was not urged. She was therefore placed alternately upon iodides and arsenic.

December 20, 1907: Patient has had no pain since last examination. No vesical symptoms.

For the past two weeks, she has felt a unilateral girdle sensation on the right side at the umbilical level, which increases in the recumbent posture.

The objective examination is unchanged, except that the left hand and arm are somewhat weaker, and the numbness of the right hand is more constant and annoying.

May 29, 1908: Patient is still free from pain; girdle sensation has disappeared. There is constant and increasing paræsthesia of the right hand. She has continued her occupation as nurse-maid and is still able to sew and work with the right hand. The objective examination practically unchanged.

March 17, 1909: For some weeks, patient has again experienced the unilateral girdle sensation on the right side at the level of the umbilicus, which was previously noted. No pain and no vesical symptoms. The cranial nerves are negative, and the objective examination remains unchanged. It was noted that the erector pili reflex is absent on the left side.

October 24, 1909: For the past two months the right hand has been stiff and awkward. The functions of the right leg, except for increasing paræsthesias and sensory loss, are unimpaired. She has experienced occasional sharp twinges of pain in the upper right intercostal region, but neither constant nor severe.

February 6, 1910: The right arm and leg are both worse. It is impossible to use the right hand now for sewing and finer work, and she was forced to abandon her occupation two months ago.

There is astereognosis of the right hand and the deep sensibility of the toes on the left side is abolished, but is present on the right. Numbness of the left leg is now present, which has ascended to the knee.

Examination.—Station shows slight Romberg. Spinal hemiplegia of the left side has increased. The cranial nerves are all normal; the optic discs are negative. Percussion of the cervical spine reveals no tenderness and no change in the percussion note. Fibrillary twitchings are present in the trapezius and supra- and infraspinatus muscles on both sides. No oculopupillary symptoms are present. The erector pili reflex is absent on the left side of the trunk, and occasional jumping and starting spasms occur in the extremities at night. No vesical symptoms.

Sensation.—The superficial sensations are very much as noted in previous examinations. There is anæsthesia from the level of the jaw, anteriorly, and from the lower occipital region, posteriorly, throughout the entire right side, which is complete over the distal portions of the extremities and the right side of the trunk and neck; it is less marked along the inner side of the arms and thighs.

The sensations of the left side of the body are normal, except for a strip of anæsthesia between the jaw and clavicle, anteriorly, and occiput and spine of the scapula, posteriorly, where the loss of pain and temperature sense is complete, and the tactile sensation is diminished but not lost.

There is marked astereognosis of the right hand. The deep sensibility of the toes on the left side is lost, but is preserved on the right.

There is a slight hyperæsthetic zone along the lower jaw on both sides and across the upper thoracic region (second and third ribs).

An exploratory operation was performed at my request, on March 28, 1910, by Dr. Woolsey. The third, fourth, and fifth laminæ were removed; the dura mater was swollen and there was no pulsation. After incision of the dura, there was a copious discharge of cerebrospinal fluid—about four ounces. In the middle of the bone wound and a little to the right of the median line, a dark and somewhat discolored spot appeared on the posterior aspect of the cord; its surface was smooth and covered by pia mater. The cord was swollen, but no other abnormalities could be detected. A puncture was made over the discolored area near the median line, and about two drachms of clear fluid escaped, and as it flowed out, the posterior aspect of the cord collapsed. The walls of the cavity, from which the fluid escaped, seen through the small puncture which was made, appeared of a brownish hue. The anterior and lateral regions of the cord and the nerve-roots were normal to the naked eye.

Examination (April 8, 1910).—Has made a good recovery from the operation. Had considerable pain in the shoulder for the first few days, and there was some weakness of the right arm, with increased weakness of the left arm and leg, which has rapidly improved. She has good control of the sphincters; there are no oculopupillary symptoms. Sensory symptoms unchanged.

Remarks.—The diagnosis of a tumor growth seemed clear from the occurrence of root pains in a circumscribed distribution, followed by symptoms of unilateral compression of the cord, gradually progressing. It was, however, by no means easy to determine whether the growth was extra- or intramedullary in origin. In favor of a tumor without the cord and compressing it were the initial pains covering a period of three years, a Brown-Séquard paralysis of very gradual development, and the extremely long and progressive course of the disease (about fourteen years). Central tumors (slowly growing glioma and gliosis) may, however, present a very similar picture, and this was regarded as the probable diagnosis. There were, however, no trophic disturbances, and the anæsthesia was not of the dissociated type, save the strip on the left side of the neck between the jaw and the clavicle. The fibrillary twitchings which were present may also occur in

extramedullary tumors, so that great weight could not be attached to their presence, and, in a hemiplegia of such long standing as had existed in the case, a kyphoscoliosis, so common in syringomyelia and spinal gliosis, would not have much diagnostic significance. As the condition of the patient grew worse and the right hand became seriously involved, she decided to submit to an exploratory operation. It is, as yet, too soon to say how great a benefit will be derived from the evacuation of the cystic fluid within the cord. The recovery from the operative procedure was rapid, and the initial operative paresis soon wore off. It is interesting to note that the girdle sensation disappeared after the operation.

CASE IX (Summary).—*Central intramedullary tumor of the cervical region, exploratory laminectomy performed; growth inoperable, and the wound closed. Recovery from the operation; patient died some months later with complete motor and sensory paralysis. Onset of symptoms with weakness and numbness of the left hand, three months later appearing in the right. Gradual progression of symptoms; weakness and atrophies of the upper extremities, anæsthesia, and spastic paraplegia. Occasional pains and symptoms of posterior root irritation in the distribution of the cervical nerves.*

History.—The patient, a married woman aged thirty-seven, was referred to Dr. Ramsay Hunt by Dr. William M. Polk. She had borne seven children, all healthy. She had had two miscarriages, and the husband gave a positive history of syphilis acquired five years before marriage. There was no history of injury. Onset of symptoms, in November, 1908, with numbness on the ulnar side of the left hand, which was soon followed by weakness of the fingers. Three months later, a numb feeling developed in the middle finger of the right hand, which gradually extended over the entire palmar surface of the hand. She had occasional shifting pains in the arms and legs, but these were not constant and not severe. She also had occasionally pains in the back of the neck. The weakness of the hands gradually increased, and the numbness extended over the palms and fingers. There are no vesical symptoms. At times she experiences a feeling of numbness over the abdomen and on the left thigh; and the left leg, subjectively, is weak.

Examination (February 27, 1909).—The gait and station are normal. Pupils are equal and react normally. There is a distinct weakness of the intrinsic muscles of both hands, which is more marked on the left. Extension of the wrists is also weak. There is a moderate degree of atrophy of the intrinsic muscles of the left hand, which is also present to a lesser extent on the right. The supinator and biceps reflexes are present; the triceps jerks are absent; the knee-jerks and ankle-jerks are active on both sides. There is no ankle clonus, and no Babinski reflex on either side.

Sensations are normal, with the exception of a strip of anæsthesia along the ulnar side of the hands and forearms on both sides, more marked upon the left. The tactile, pain, and temperature sensations are all equally involved (there is no dissociation of sensibility). The spinal column is perfectly mobile, and there are no areas of tenderness.

April 28, 1909: The patient's condition is distinctly worse in spite of a thorough course of iodides and mercury. The hands are weaker, and she complains of the legs and trunk feeling numb and cold. There are also slight twitching and trembling movements in the fingers (coarse fibrillations); no oculopupillary symptoms. The sensations are about the same as at the last examination, except that the strip of anæsthesia which was present on the ulnar side of hands and forearms has ascended along the inner side of the left upper arm.

June 1, 1909: For the past ten days had had vesical trouble for the first time, which followed a very severe paroxysm of pain in the neck and arms, lasting several weeks. Coinciding with this paroxysm of pain, the left pupil became temporarily smaller than the right, and there was a slight drooping of the left eyelid. The left leg was also the seat of transient weakness.

June 22, 1909: Movements of the neck are free, and there is no pain except occasional painful paræsthesias in the left hand. The eyes are normal, and there are no vesical symptoms. At times the left hand swells and becomes red and tender. The left leg, subjectively, is weak and numb. The hands are weaker, and the anæsthesia has extended to the trunk upon the left side, reaching from the third intercostal space on the left side to the level of the umbilicus; all sensations are involved. The strip of anæsthesia on the arms, which at the last examination was con-

fined to the inner side of both upper extremities, has now passed around and includes the posterior aspect as well. Her condition has grown steadily worse, notwithstanding a hypodermic course of mercury and large doses of the iodides. The question of exploratory laminectomy was discussed, but it was decided to wait until the autumn, unless her symptoms took a sudden turn for the worse.

September 17, 1909: During July and August she had a few attacks of pain, centred in the midspinal region at the level of the sixth and seventh cervical vertebræ. These paroxysms of pain, however, were not so severe as the one noted in June. For the past few weeks she has had difficulty in controlling the sphincters, and the legs are growing weaker. The weakness is greater on the left side, and although she stands and walks well there is a tendency to drag the left leg. The right pupil is larger than the left, but there is no ptosis and no enophthalmos. The cranial nerves are normal. Ankle clonus is present on both sides, more marked on the left, and Babinski reflex on both sides. The spinal column is negative. There is complete anæsthesia to touch, pain, and temperature below the level of the third rib anteriorly, which includes the inner and posterior aspect of both upper extremities. The articular sense of the toes is also disturbed on both sides. The hands are weaker, their intrinsic muscles are more atrophied, and fibrillary twitchings are present.

October 6, 1909: For the past three weeks has had considerable pain in the back of neck, extending up to the occiput. Percussion of the spine is negative, and there is no tenderness or rigidity. Weakness of the sphincters of the bladder and rectum. There is extreme weakness of the movements of the wrists and fingers and extension of the elbows, more marked upon the left side. The flexion of the elbows and movements of the shoulders are well preserved. The oculopupillary symptom (ptosis, myosis, and enophthalmos) typically present on the left side. There is spastic paraparesis of the lower extremities, with clonus, more marked on the left. Superficial sensations are practically abolished below the level of the third rib anteriorly. The abdominal reflexes are absent.

An exploratory operation was performed October 11, 1909, at my request, by Dr. Frank Hartley at the New York Hospital. The spines and laminæ of the sixth and seventh cervical vertebræ

were removed. The dura does not pulsate and appears distended. After it was incised, there was a gush of cerebrospinal fluid under considerable pressure. The pia mater is smooth and glistening, but the cord itself is swollen, and is of a pinkish and mottled hue. It evidently contains an intramedullary tumor; extirpation was impossible. Exploratory puncture of the cord was not deemed advisable, and the wound was closed.

The patient recovered from the effects of the operation, but her condition grew steadily worse and she died four months later, having developed a total transverse lesion of the spinal cord, with contractures and bed-sores. No autopsy was performed.

Remarks.—The symptoms and clinical course of this case were in favor of a central, intramedullary tumor of the cord. She had experienced, however, from time to time, severe pains in the neck in the distribution of the cervical nerves, and as all other forms of treatment had been of no avail, and her condition was gradually progressing, it was deemed wise to give her the benefit of the doubt and explore the spinal cord at the diseased level. I would emphasize the fact that at no time did she present a definite dissociated anæsthesia (loss of pain and temperature sense), which is so common in central tumors. This, in conjunction with the symptoms of posterior root irritation, were regarded as sufficient to justify the exploration.

CASE X (Summary).—*Spindle-cell sarcoma of the meninges at the level of the second, third, and fourth dorsal segments. Exploratory laminectomy, but extirpation of the tumor was impracticable, and the wound was closed. Onset of symptoms December, 1901, with lancinating pains between and beneath the shoulder-blades, also encircling the chest in the upper intercostal spaces. Six months later, bilateral symptoms of spinal cord compression, which rapidly progressed to complete motor and sensory paralysis. Rigidity of cervical and upper dorsal regions, with localized tenderness.*

Patient, a man aged twenty-three, was admitted to Bellevue Hospital in the service of Dr. Dana, through whose courtesy I was enabled to observe the case. He denies syphilis, and gives no history of injury. In the latter part of December, 1901,

he was seized with pain in the upper portion of the back between the shoulder-blades, which was especially severe and constant over the lower angle of the right scapula. At first the pain occurred only at night, and during the day he was practically free from it. Later the lancination became more severe, and radiated into the upper intercostal spaces on both sides; at times there were sharp pains in the depths of the axilla, which would shoot into the arm. In July, 1902, the lower extremities became weak and numb, and there was retention of urine. At this time there were frequent spasmodic twitchings of the lower extremities, and the legs would be drawn up under him by spontaneous contractions. By the latter part of July, the lower extremities were so weak that he was forced to take to his bed, and a complete paraplegia with incontinence of urine and sensory disturbances supervened.

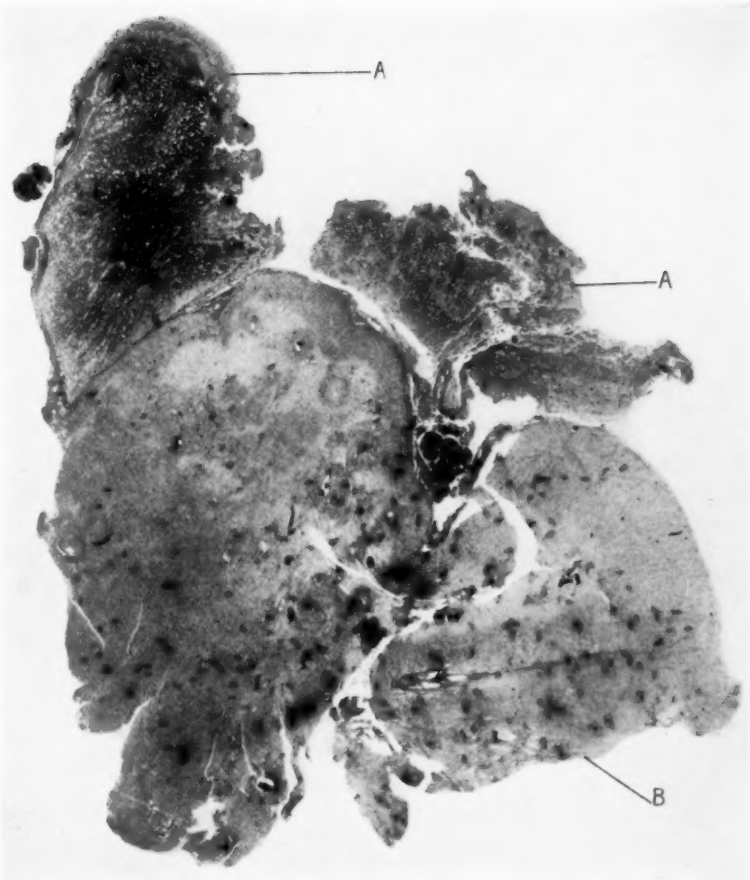
Examination (October, 1902).—The cranial nerves and pupillary reflexes are normal. Gross motor power, the sensation, and reflexes of the upper extremities are normal. The head is held in a position of fixation; lateral movements may be carried out, but are somewhat restricted. There is considerable restriction of the forward and backward movements of the head. Palpation of the pharynx is negative. In the upper dorsal region, corresponding to the sixth, seventh, and eighth dorsal spines, there is a slight prominence, and a distinct area of tenderness to the left of the sixth dorsal spine. Jarring of the vertebral column does not produce pain. There is complete paraplegia, with incontinence of urine, ankle clonus, Babinski, and exaggeration of the tendon reflexes. The abdominal and cremasteric reflexes are absent. There is also complete anæsthesia, reaching as high as the nipple line anteriorly, and the fifth dorsal spine posteriorly. Immediately above the line of anæsthesia is situated an hyperæsthetic band about three inches in width. The temperature is generally normal, but there are occasional rises to 100° and 101° F. The lungs are normal. On November 18, an injection of tuberculin was made, with negative result. On December 1, another injection of tuberculin was followed by a rise of temperature to 103.6° F., the highest point which the temperature had yet attained. Antisyphilitic remedies had been tried without avail, and as fixation and extension of the spine had produced no amelioration of symptoms, an exploratory operation was decided upon.

Operation (December 17, 1902).—Operation by Dr. Gallaudet. Ether anæsthesia. An incision was made in the median line over the upper dorsal region. The spines and laminæ of the fourth, third, second, and first dorsal vertebræ were removed in turn. No abnormality of bone or dura was detected. The dura was somewhat swollen and did not pulsate. On incising it, at the level of the second dorsal spine, the spinal cord bulged through the opening and was found to be enlarged, softened, and of a whitish color. The tumor could not be demarcated from the surrounding cord substance, so that any attempt at extirpation was found to be impossible and the wound was closed. The patient recovered from the immediate effects of the operation, but died January 3, 1903.

No autopsy was performed, but the wound was opened, and a section of the spinal cord between the seventh cervical and fifth dorsal spines was removed. At its middle portion, which corresponded to the second and third dorsal segments, there is a large tumor mass two inches in length and three-quarters of an inch in width, which is irregularly nodular externally and presents a white homogeneous appearance on the surface of section. The growth is intimately attached to the inner surface of the dura and the pia mater, and has caused almost complete destruction of the cord (see Fig. 3). Histologically, the growth is a spindle-cell sarcoma, apparently taking its origin from the inner surface of the dura, although sarcomatous infiltration is also present on the external surface of the pia arachnoid (see Fig. 4). The cord substance itself is compressed but not infiltrated (compression myelitis).

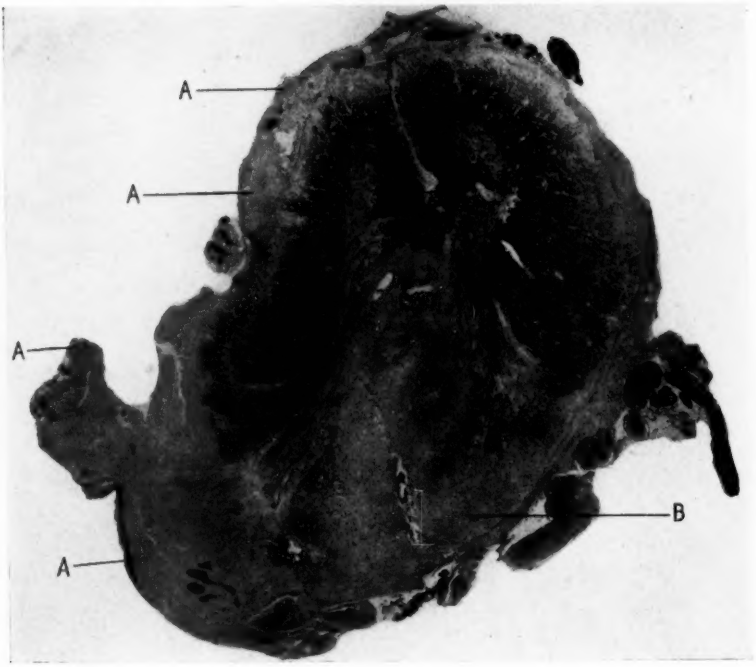
Remarks on Symptomatology.—The onset of the clinical picture, with lancinating pain, bilateral and segmental in distribution, followed in six months by symptoms of rapidly developing medullary compression, were in favor of a rapidly growing neoplasm. There was, however, some uncertainty regarding the nature of the affection. For a time, tubercular caries, with compression, was considered, and this view was confirmed by what seemed to be a positive tuberculin reaction. The rigidity, with slight vertebral deformity at the level of the sixth, seventh, and eighth dorsal spines, with tenderness

FIG. 3.



Case X. Spindle-cell sarcoma of the meninges, compressing the cord at the third and fourth dorsal segments (Weigert-Pal method). *A*, remains of spinal cord; *B*, tumor.

FIG. 4.



Case X. *A*, spindle-cell sarcoma of the pia mater surrounding and compressing the anterior and posterior nerve roots; *B*, ascending degenerations in the posterior columns. (Weigert-Pal method.)

and occasional rises of temperature, were also in favor of this view. There was, however, no pain on jarring the vertebral column. A syphilitic affection was also considered, especially the pachymeningitis syphilitica, but no amelioration of symptoms followed the use of iodides and mercury, so that, as a last resort, an exploratory laminectomy seemed advisable.

CASE XI (Summary).—*Onset with shooting pains in the hips, lower lumbar region, and front of the thighs. Four months later, weakness of the lower extremities, with paræsthesia and sensory disturbances. Rapid progression of symptoms, followed by complete paralysis of motion and sensation below the level of the twelfth dorsal segments. Extreme atrophy of the muscles in the gluteal region on both sides. Autopsy revealed a spindle-cell sarcoma of the meninges, with complete destruction of the cord in the lumbar region.*

History.—The patient, a woman twenty-three years of age, was seen in consultation by Dr. Ramsay Hunt with Dr. R. L. MacFarland at the Jamaica Hospital, L. I. There was no history of syphilis or injury. Onset of symptoms in April, 1902, with shooting pains in the region of the right hip. A few weeks later, similar pains, of lancinating character, were felt in the corresponding region of the left side. She also had pain in the lower lumbar region, and, later, shooting pains down the anterior and lateral aspect of the thighs. These pains continued during the early summer and were very severe. The last of July, weakness and paræsthesias of the lower extremities made their appearance. In August, the right leg was completely paralyzed, and the left partially so, with marked sensory disturbances. There was also retention of urine followed by incontinence. In November, the paralysis was complete. During this time lancinating pains had continued, but with less intensity.

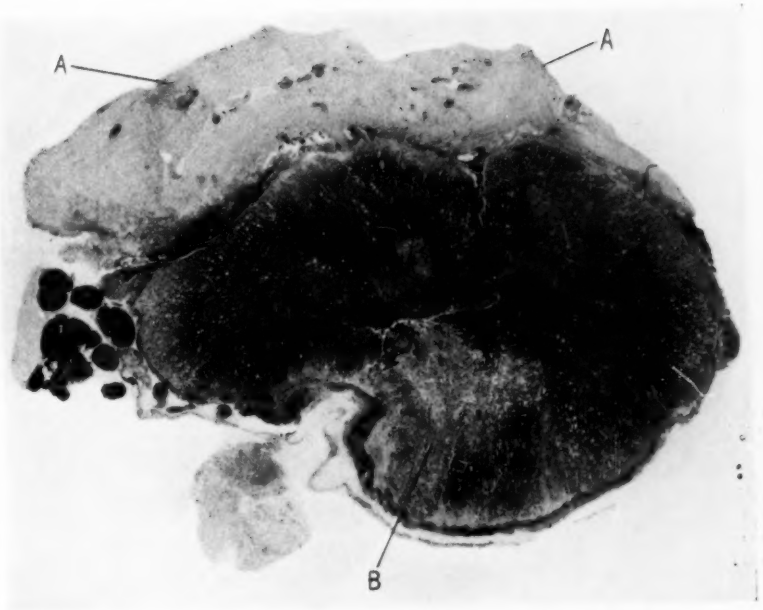
Examination (February 28, 1903).—The patient is well built and somewhat emaciated. Above the waist-line the physical examination is negative. There is a slight lateral curvature of the spine in the dorsolumbar region, but no kyphosis or abnormal projection of the spinous processes. The tenth and eleventh dorsal spines are very tender on direct pressure, but jarring produces no pain in the vertebral column at this level. In the sitting posture, there are pain and a girdle sensation which encircles the

body at the umbilical level. Posteriorly, there is practically complete atrophy of the gluteal muscles on both sides, so that all the anatomical landmarks of the pelvis stand out clearly on its posterior aspect. No fibrillations. The thighs and legs present a slight degree of general wasting, but no definite localized atrophy, as in the buttocks. There is a complete flaccid paraplegia, with loss of tendon and plantar reflexes. There is also complete loss of all sensation below a line midway between the navel and pubes anteriorly and the fifth lumbar spine posteriorly. The feet and ankles are somewhat œdematous. There is a bedsore over the sacrum, and others over the left buttock and the left heel.

The diagnosis was made of a rapidly growing tumor compressing the spinal cord in the lumbar region. The case was regarded as unfavorable for operation. A few months later the woman died, and the *autopsy* revealed a sarcoma of the meninges in the lumbar region. The vertebræ were free from disease. Through the kindness of Dr. MacFarland, the lower portion of the spinal cord was sent to me for examination. The tumor mass is a spindle-cell sarcoma, three inches long, and lay on the right anterolateral aspect of the lumbar cord. It apparently takes its origin from the inner surface of the dura mater. There is no evidence of growth on the external surface of the dura. The cord was not infiltrated by the growth, but was completely disorganized by the compression to which it was subjected. The tumor growth infiltrates the pia arachnoid on the anterior aspect of the cord in the lumbar region, surrounding and destroying the anterior roots (see Fig. 5).

Remarks.—This case is very similar in its course and symptomatology to Case X. Onset with lancinating pains in the distribution of the first, second, and third lumbar segments, which were followed in about three months by the symptoms of medullary compression, which progressed rapidly to complete motor and sensory paralysis below the level of the twelfth dorsal segment. Practically, the symptoms were bilateral in distribution, although the initial pain was felt first on the right side, and the right leg was the first to become weak. The extensive early wasting of the muscles of the buttocks

FIG. 5.



Case XI. Spindle-cell sarcoma of the meninges, showing infiltration of pia mater on the anterior surface of the cord, surrounding the anterior roots. *A*, tumor growth; *B*, degenerations in posterior columns. (Weigert-Pal method.)

is probably due to invasion of the anterior root of the lower lumbar and upper sacral segments. I consider the short duration of the root pains, their bilateral distribution, and the early appearance of symptoms indicating medullary compression as distinctly unfavorable signs as regards the operability of the tumor—these symptoms suggesting a rapidly growing malignant neoplasm of inoperable character.

CASE XII (Summary).—*Onset with pains in lumbar region followed by lancinations in the distribution of the first lumbar segment on both sides. Ten months later, gradual development of a compression paraplegia. Vertebral column practically negative, save for an insignificant prominence of the tenth dorsal spine. Exploratory laminectomy revealed an infiltrating tumor of the spines and laminæ of the eleventh and twelfth dorsal vertebræ, compressing the nerve roots in the intravertebral foramina as well as the cord within the spinal canal. Pathological diagnosis—carcinoma (a small scirrhus growth was later discovered in the left breast which had remained latent).*

History.—The patient, a woman aged forty-seven, was referred to Dr. Ramsay Hunt by Dr. Frank Meara on December 26, 1908. She had borne two healthy children, and had had two miscarriages; no history of injury. She is well nourished, has a good color, but is very nervous as the result of her long suffering. Her illness began in December, 1907, with pain in the lumbosacral region, regarded at first as probably rheumatic, but which did not respond to treatment. These pains in the lumbosacral region continued with variable intensity until May, when there was an interval of about six weeks in which she was entirely free. The pains in the lower lumbar region then reappeared, and were accompanied by shooting pains around the hips on both sides. When severe, the pains extended up the spine between the shoulders. The pains continued during the entire summer, increasing in severity, and in November, 1908, was first noticed an unusual coldness of the feet below the ankle (sensation of freezing). This was soon followed by paræsthesias of the feet and ankles and, later, weakness, more especially of the left leg. When the lumbosacral pains were especially severe, the back became quite stiff in this region. No shooting or lancinating pains were felt except around the hips, and these were equal in intensity on the two sides. No vesical symptoms.

Examination (December 27, 1910).—Patient is bed ridden and cannot stand or walk without assistance. The spine is normal in mobility and in appearance (no deformity). There is absolutely no pain on jarring; there is, however, some tenderness on pressure over the second and third lumbar spines (which was slight and was not confirmed on subsequent examinations).

There is a spastic weakness of the lower extremities, more marked of the left leg, on which side ankle clonus is present; Babinski reflex present on both sides; abdominal reflexes present and active. There is a band of hyperæsthesia and hyperalgesia in the lower lumbar region, which encircles the body at the level of the groins.

Sensations.—The temperature sense of the lower extremities is disturbed. Tactile, pain, and deep sensibility are normal. There are areas of analgesia over the right hip in the distribution of the first lumbar nerve.

January 16, 1910: Patient was again examined in consultation with Dr. Dana. She still has pain in the lower lumbar region, especially at night, but less severe than formerly. Lancinating pains are still felt around the hips, of equal intensity on the two sides. No vesical symptoms. Weakness of the legs has progressed, in spite of the administration of iodides.

The spine is absolutely normal in appearance and mobility, and there is no tenderness demonstrable on pressure.

Sensations.—There is distinct loss of pain and temperature sensibility over the lower extremities, with preservation of the tactile sense. In the distribution of the first lumbar segment on both sides, distinct areas of anæsthesia to pain and touch are present.

February 26, 1910: Her condition is worse, paralysis has increased, and sensation shows greater impairment. There is now some disturbance of the vesical function. In the sitting posture there is noticeable for the first time a very slight prominence of the tenth dorsal spine. It is not marked, and there is no tenderness on pressure. Jarring of the spine produces moderate pain, which radiates in the region of the hips. There is an "erector-spinæ reflex" in the lumbar region, stroking or pricking of the skin invoking a muscular contraction.

March 5, 1910: Paralysis of motion and sensation continues to increase. Marked vesical disturbance. There is still pain in

the lumbar region and the hips. Sensation of pain and temperature especially, but also tactile sensibility is disturbed as high as the distribution of the first lumbar segment. The spinal column is perfectly normal in its mobility, and there is not the slightest trace of rigidity or of tenderness. *There is no pain on jarring.* The tenth dorsal spine is still slightly prominent, but this has not increased. There has been no elevation of temperature during her illness. The lungs are normal, and the other internal organs are negative. It was decided to perform an exploratory operation.

March 10, 1910: Exploratory laminectomy was performed by Dr. Frank Hartley at the New York Hospital. The spines and laminæ of the tenth, eleventh, and twelfth dorsal vertebræ were removed. On cutting away the spines from the eleventh and twelfth dorsal, they were found to be softened and infiltrated with tumor growth, which could be traced into the lumbar muscles of the left side. The roots of the twelfth dorsal and the first lumbar segments passed out through the growth on both sides. A collection of tumor tissue was also found within the spinal canal on the left side at the level of the twelfth dorsal and first and second lumbar segments, which had compressed and deformed the cord. The dura mater was normal in appearance and was not incised.

Immediately after the operation, patient went into collapse but revived after stimulation and the subcutaneous infusion of a salt solution. Histological diagnosis of tumor—carcinoma.

Note.—Following the pathological report, a careful palpation of the breasts was made, which revealed a small fibrous nodule on the left side. This had never been the seat of pain, and its presence was unknown to the patient. It was apparently a latent carcinoma of the breast which had caused no local symptoms. The patient made a good recovery from the operation, but the only result achieved was the amelioration of pain. Six weeks later, general cerebral symptoms developed and progressed rapidly, with stupor and choked discs, probably due to metastases in the brain. No autopsy was performed.

Remarks.—Prior to the operation in this case the symptoms were regarded as indicating in all probability an extradural tumor, compressing the posterior roots at the first lumbar

segment and later causing a spastic paraplegia from pressure upon the cord. The possibility of a primary growth of the vertebral column was very carefully considered, because of the long duration of pains in the lumbosacral region which persisted throughout the course of the disease. Owing to the complete absence of rigidity of the spinal column, and any constant point of tenderness or pain on jarring, an intravertebral growth (extradural) was regarded as very probable. For this reason, an exploratory operation was determined upon. The prominence of the tenth dorsal spine was so very slight that it did not weigh much in the scales against the practically complete absence of other vertebral symptoms; and severe localized pains over the spine at the level of the tumor, I have had occasion to observe in intravertebral growths as the result of meningeal irritation.

Operation showed that there was an extradural tumor in the vertebral canal which had also compressed the nerve-root of the twelfth dorsal and first lumbar roots, in their respective foraminæ, and so far the diagnosis was correct. The small latent growth in the left breast could have easily been detected had a careful search been made, but in the complete absence of subjective symptoms it was overlooked. The case is instructive in that a carcinoma metastasis of the spine may produce a symptom complex simulating very closely that of an extradural growth, in which the symptoms of vertebral involvement are absent or comparatively slight.

CASE XIII (Summary).—*Melanoma of the sacrum, with compression of the cauda equina.*

Onset, September, 1906, *with pains in the distribution of the third, fourth, and fifth sacral segments on the right side, followed by paræsthesias, diminution of the right knee-jerk and loss of the Achilles-jerk on the right side. In addition there was deep-seated bone pain and tenderness over the sacrum, the right tuber-ischium, and the right side of the pubes.*

Exploratory operation (by Dr. Woolsey).—*Removal of the first, second, and third sacral and fifth lumbar segments, which were found red and softened, and the seat of tumor infiltration.*

The patient made a good recovery from the operation, but died two months later, greatly emaciated, with paralysis of the lower extremities and incontinence of the sphincters.

History.—The case was referred to Dr. George Woolsey by Dr. A. F. Warren of Chicopee Falls, and was seen in consultation by Dr. Dana and Dr. Hunt. He is sixty-eight years of age, and is a retired seafaring man. He was admitted to the Presbyterian Hospital on April 12, 1907. The symptoms of his trouble began in September, 1906, with pain in the right perianal region. This pain grew steadily worse and became a constant soreness and aching, so that he was forced to sit almost entirely upon the left side. He had been a sufferer from hemorrhoids for some years, and it was supposed that his pains were due to this cause. An operation for the relief of hemorrhoids was then performed in Chicopee Falls, but after a transient period of relief the pains returned with increased severity, and in addition to the constant aching pain in the perianal region, he also experienced lancinations down the back of the right thigh and over the right side of the buttock. He occasionally has deep-seated pain over the right inguinal region. In the course of a few weeks there appeared paræsthesias in the right perianal region, and the posterior surface of the right thigh. The genitalia also became numb, and he did not have proper control over the sphincters of the bladder or of the rectum. The sexual power has also failed and he is now impotent. There was little or no sensation of urine passing through the urethra and the passage of fecal matter was not attended by the customary sensations. There is some numbness over the left buttock as well. He has lost about 20 pounds in weight during the past few months. In December he commenced to limp badly with the right leg. When the pain is severe, he gets most relief by standing; in the recumbent posture, he lies with the right leg flexed.

Examination (March 5, 1910).—Patient is a small, poorly nourished man, is emaciated, and considerably prostrated by his illness. He is able to stand and walk, and the motor power of the lower extremities is good. The spine is normal in appearance and in mobility. There is a distinct area of tenderness over the upper portion of the sacrum. There is also deep-seated bone tenderness over the right side of the pubic arch, the right tuber-

ischium, and over the middle of Poupart's ligament. The movements of the hip-joint are free and unrestricted; there is no tenderness along the nerve-trunks. The right thigh and right leg are one-half inch less in circumference than on the left side, but the gross motor power is well preserved. The knee-jerk is diminished on the right side, and the Achilles-jerk is lost. The plantar, abdominal, and cremasteric reflexes are all present and normal.

Sensations.—There is a longitudinal strip of anæsthesia which extends along the posterior aspect of the thigh in the distribution of the third sacral segment. The tactile sensibility of the external genitalia and perianal regions is diminished. Rectal examination shows a relaxed sphincter, and, upon the right side of the pelvic wall near the sacrosciatic notch, there is felt a firm nodular body, freely movable, which suggests an enlarged gland. The bony structures are normal to the touch.

Examination of the urine for Bence-Jones albumin yielded a positive reaction on several occasions; at other times the tests were negative.

On March 16, 1910, an exploratory operation was performed by Dr. George Woolsey at the Presbyterian Hospital. The spines and laminæ of the three upper sacral and the fifth lumbar vertebræ were removed. On exposing the sacrum, the bone was found to be softened, spongy, and red in color, so that it could be easily scooped out and scraped away with a curette, and was very evidently diseased. The dura mater was incised, and a free flow of cerebrospinal fluid took place. The roots of the cauda equina were found to be normal, and a probe passed up the canal for two or three inches met with no resistance.

Pathological diagnosis of tumor was melanoma.

Note.—The patient made a good recovery from the operation, the wound healing by first intention. After the operation the pain was somewhat less, but the anæsthetic area remained unchanged. He was discharged from the hospital on April 12. Dr. Warren, his family physician, informed us that soon after the patient returned home, the pain increased and the right leg became paralyzed. Later the left leg was similarly affected, and there was complete incontinence of urine. He was unable to assume a sitting posture on account of the very severe sacral pain. He died six weeks after leaving the hospital, greatly emaciated.

Remarks.—It was very evident from the sacral pain and tenderness, as well as tenderness over other bony structures of the pelvis, that we were dealing in this case with a tumor of the sacrum, which had compressed the strands of the cauda equina. The pains were so intense and intolerable that an operation was deemed advisable for the relief of pressure. The result, however, was not very satisfactory.

SURGICAL PAPER BY DR. WOOLSEY.

The technic of operations for the removal of intraspinal tumors first involves a laminectomy. At the outset we must determine whether we will do a simple or an osteoplastic laminectomy. My personal preference is strongly in favor of a simple laminectomy, for as a rule the simplest technic is the best. It gives the best and most free exposure and can more readily be extended in either direction to meet the conditions in a given case. It is the easiest, takes less time and is the safest. It does not essentially weaken the strength or the carrying or supporting power of the spine to remove three to five laminæ, for the latter do not bear any weight except possibly to a slight extent in the upper cervical region. This is also borne out by experience. The cord is amply protected by the thick covering of muscles and fascia over the firm theca. Furthermore as, before the removal of the laminæ, an attempt is often made to spare the superficial periosteum, more or less of a bony covering may be reproduced. This was not found to be present however in Case III, reoperated one year after the first operation. The spine is somewhat stiff at the laminectomy site but no more stiff, if as much so, as where an Urban or Hartley-Bickham operation is done.

If any form of osteoplastic operation is done the only one I would consider would be that known as Cavicchia's as practiced by Durante. Abbe has employed a very similar procedure in the intraspinal division of the posterior nerve roots for neuralgia and also in operations on intraspinal tumors. It consists of laying back a muscular flap including the spinous processes. Through a slightly curved or angular

incision a little to one side of the median line the superficial muscles are split longitudinally a little to one side of the spines, the longissimus dorsi group of this side is divided transversely at the upper and lower ends of the slit and retracted toward the median line to allow the division of the spines at their bases. The muscles of the opposite vertebral groove are then elevated from the laminæ and retracted, with the severed spines and longissimus dorsi to allow the removal of the laminæ. There is little if any less hemorrhage than in simple laminectomy, in which the hemorrhage is readily controlled. The only bony portions left are the spines, and these can add little if any to the strength of the column. Besides, in the dorsal position the rough bases of the spines are pressed toward the dura and might possibly cause irritation of it. The method therefore seems to me inadvisable and should be discarded in favor of the simple laminectomy. The unilateral laminectomy employed by Taylor in the intraspinal division of posterior nerve roots does not give sufficiently free access for the removal of tumors. Sonnenburg attributed a fatal result from meningitis, due to infection, to the use of Urban's osteoplastic method.

A modified Sims' position on the left side with the patient as prone as possible, is suitable for any part of the spine. The patient should be on the left side, as this is more convenient for the operator, whether the tumor is on the right or left side. Or the patient may lie prone on the belly. The part to be operated on should be flexed as much as possible, to facilitate the laminectomy by separating the laminæ as much as possible and by making the spines prominent posteriorly; and it should be higher than the head and the rest of the spine as well to limit the escape of cerebrospinal fluid when the dura is opened. This position can be quickly obtained in part by lowering the head somewhat in the Trendelenburg position, or, better, by the use of the Lilienthal bridge on the operating table. The use of cushions under the part of the spine to be operated on answers all purposes in most cases. When the operation is upon the cervical region the prone

position, with the head supported on an extension head rest and the shoulders raised so as to allow thoracic and abdominal respiration, is a convenient one.

In view of the fact brought out by Crowe,[14] that urotropin is excreted by the cerebrospinal fluid, fifteen grains of this drug should be administered shortly before the operation, as its maximum concentration in the fluid occurs from one-half to one hour after its ingestion. It should also be continued after the operation in divided doses for several days, giving thirty grains or more every twenty-four hours, on account of its inhibitory effect on the growth of organisms in the cerebrospinal fluid, thus minimizing the danger of meningitis.

In order to determine the position of the incision the spine or spines should be found under whose neural arch the neurologist has localized the tumor. Except in the cervical region it is better to count the spines from above and below, above from the vertebra prominens, below from the fourth lumbar spine, on a level with the highest point of the iliac crests. In patients not too stout we can follow up the twelfth rib to the upper end of the twelfth thoracic vertebra as an additional landmark. It is also convenient to remember that the vertebral end of the spine of the scapula corresponds to the third thoracic spine, for in some cases, where the sixth cervical spine is more, or the seventh less, than usually prominent, it is hard to make sure of the vertebra prominens and to distinguish it from the sixth cervical or the first dorsal spines. When in such cases it is difficult to count the spines accurately, all such accessory landmarks are useful. In operations on the cervical region, after the spinous processes are exposed, it is well to remember that the spine of the sixth cervical vertebra is the lowermost bifid spine of the cervical vertebræ.

If a bed-sore exists on the back it should be thoroughly treated by 95 per cent. carbolic acid, followed by alcohol and then painted thickly with iodine. The area should then be excluded from the field of operation by a light dressing covered with thick gutta-percha tissue fastened to the skin around it by chloroform.

The median incision, having its centre opposite the diagnosed position of the tumor, is carried down directly to the tips of the spines and should be ample, at least 10 cm. and often 15 cm., corresponding to a minimum of three or four spines and often to five or more. A transverse incision through the aponeurosis at either end of the incision may be made to allow of easier retraction of the edges and exposure of the spine, but is not necessary. After dissecting around to either side of the three or more spines exposed, the soft parts are rapidly removed from either side of them by blunt dissection, aided by the knife, down to their junction with the laminæ. It is not necessary to do this subperiosteally. To give more room for the next step, the clearing of the soft parts from the laminæ, the spines may now be cut off at their bases by a bone forceps bent on the flat, after dividing the supraspinous and interspinous ligaments between them, or this step may be deferred until the laminæ are cleared. The latter is accomplished by a periosteal elevator or raspatory, by which it is sought at the same time to strip back the periosteum. In freeing the soft parts from the spines and laminæ, there may be considerable hemorrhage, mostly venous, but this is not invariable. This is readily controlled by packing with gauze wet with very hot salt solution alternately on the two sides, as we work on the opposite side. Few if any vessels require the use of forceps or ligature.

When the entire laminæ have been cleared their removal is the next step. This may present some difficulty at first, especially in the thoracic region where the laminæ are more imbricated. The difficulty lies in effecting the first entrance into the canal, the rest is easy. To effect this entrance one may use a Hudson or Doyen burr or a trephine, others use a bone-cutting forceps, and Bickham recommends a Doyen hand saw, for the entire removal of the laminæ. A quick, safe and easy method is to use a rongeur bent on the edge with a flattened lower blade, beginning along the lower border of the laminæ. With the same instrument, or a more powerful one, the laminæ of three or four vertebræ are removed

piecemeal to their outer limit. This is accomplished easily and quickly as soon as an entrance is made into the canal. If a hand saw is used the saw cut must be directed somewhat obliquely inward so as not to saw down into the pedicles. Some use a Gigli saw after an entry is made into the canal, but it is difficult to pass and hence is objectionable. With the use of a rongeur there will be little or no trouble with hemorrhage from the bone, but if the oozing from the bony surfaces is troublesome it may be checked by crushing the surface with a blunt rongeur or the pressure of an elevator, etc., by hot pads or by Horsley's wax. To give room for the operation within the canal and to allow for the possible uncertainty of localization, the laminæ of at least three and perhaps four vertebræ should be removed. But it may be preferable to open the dura after the removal of the laminæ of two vertebræ to see whether the laminæ above or below require removal.

So far the operation has been merely a laminectomy. The ligamenta subflava may adhere to the dura, but are readily peeled off, and the fat surrounding the dura is now exposed. If there is an extradural tumor, it is now exposed if, as is the rule, it lies in whole or in part on the dural aspect. If the tumor is extradural we proceed to remove it, removing as many more laminæ in either direction as may be necessary, for extradural tumors, especially cysts, often extend a considerable distance longitudinally within the canal. Care should be taken in separating the tumor from the dura, from which it commonly grows, to avoid injury to the latter, unless on account of its involvement a section of it must be removed. If an opening has been made in the dura with loss of its substance we may try to close it by suturing some of the overlying soft parts to the edges of the defect.

Starr advises opening the dura in extradural tumors, as a secondary growth may be found within it, but it is not often done. Before opening the dura a strong probe or a Horsley dural separator should be used to explore the extradural portion of the canal above or below the opening to make

sure that no extradural cause of pressure exists. The compressing masses of cicatricial tissue, secondary to a healed tuberculous process, which have been removed by Macewen, Trendelenburg and others, are extradural in position.

If no tumor is found extradurally, we expose the dura by pressing back the fat from either side of an incision in the median line and observe whether or not all the dura exposed pulsates. Lack of pulsation indicates increased intradural tension or shutting off of the arachnoid space at or above the point exposed, by a tumor, cyst, adhesions or some other cause. The dura should be palpated before it is opened, though an intradural tumor is not usually demonstrable before the dura is opened, even if it is situated posteriorly. If the dura feels more tense and elastic than usual, a tumor or some other cause of increased intradural tension probably exists. The dura is opened by the point of a knife and slit up and down in the posterior median line, the length exposed, by a pair of fine scissors. Its margins are held apart by silk retraction sutures, forceps or retractors. The cerebrospinal fluid escapes at first to some extent, sometimes as if under considerable pressure, but it offers no trouble by its continued flow, for it quickly ceases if the part operated upon is made higher than the rest of the spine and the head. In my first case, a tumor in the cervical region, I gently packed off the canal above the site of operation with gauze, but this was found unnecessary in subsequent cases even in the cervical region, though in the neck it is not so easy to give the spine a position higher than the rest of the arachnoid fluid. Schede used and spoke highly of Sick's proposal to pass a temporary elastic ligature outside the dura to shut off the fluid by its pressure, but this is more objectionable than packing off with gauze.

After exposing the cord, it is often not an easy matter to say at once whether there is a tumor present or not, or if present what its exact position and limits are. We can say that the cord does not appear normal and is prominent, but we may not be sure whether this is due to an intra- or an

extramedullary tumor. This is an important point and the cause of this difficulty lies in the fact that, in many cases at least, the arachnoid over the tumor is thickened and presents a number of lamellæ, often œdematous, which must be divided until the tumor or cyst, or both, are exposed. Sometimes one finds localized collections of fluid shut in between these thin lamellæ of arachnoid in the vicinity of a tumor, as in Case IV. Spiller, Munro, Krause and others have described encapsulated collections of cerebrospinal fluid which of themselves caused pressure symptoms, without other cause. In Cases II and V, I found a cyst, whose walls were formed by these lamellæ, about the tumor so that on opening the cyst, the tumor was fully exposed, though in Case V it was evident that a tumor was present in a dorsomesial position as soon as the dura was opened.

As a rule the tumor is on the dorsal aspect of the cord. This was so even in Case IV, where the motor symptoms predominated and the sensory symptoms were slight. The tumor may extend laterally or even ventrally as in Case I, so as to require the division of one or two posterior nerve roots. It is always advised to suture such divided roots, but as degeneration occurs in an ascending direction into the cord from the point of section and as no regeneration occurs in the fibres within the cord, I can see no object in such suture. If repair were to be expected under these conditions, the division of the sensory root of the Gasserian ganglion, proposed by Spiller and Frazier for tic douloureux, would be useless and the small length of the posterior spinal roots resected to cure intractable neuralgia (Abbe) would not insure against recurrence. Moreover the division of one or even of two posterior nerve roots intraspinally would have no serious effect on the sensation of the part supplied, for according to Sherrington and Greenbaum a given cutaneous area is supplied not by a single nerve root alone but by the root (or two roots) on either side of it, so that it would require the division of at least three successive roots to produce cutaneous anæsthesia. After division of one or two posterior roots the

cord may be gently retracted or pushed to the opposite side to give access to a tumor situated anteriorly.

When the tumor is exposed it is commonly found to be encapsulated and can usually be enucleated with only trifling hemorrhage by blunt dissection by the finger, a pair of forceps, a small scoop, or a Horsley's blunt separator. A few firmer strands of tissue may require division and at times one or more small vessels may require ligation by very fine catgut. The tumor, especially if of any size or of long standing, flattens the cord in a scaphoid manner, by bulging into the central part of the flattened area. The separation of the tumor from the cord is the first step in its enucleation and this may involve the division of a thin layer of tissue connecting the coverings of both. At times the tumor is found to grow from or to be so incorporated with one or more nerve roots (usually posterior roots) as to require their resection. To avoid any additional compression of the cord in enucleating the tumor, it may be wise in some cases to remove longitudinal wedge-shaped pieces from the tumor to reduce its bulk. After opening the dura sponging should be done with the greatest gentleness and care and to clear the field of operation drip irrigation with warm normal saline is preferable to sponging. In order to get above and below some of these tumors, we may have to remove two or three more laminæ. Thus in Case IV it was necessary to remove five or six laminæ to reach the limits of the growth.

Also if no tumor is found we should not hesitate to remove the laminæ higher up, to the uppermost limits indicated by the slightest changes in sensation. Even five or more laminæ should be thus removed if necessary, for there is less danger of a mistaken diagnosis than in failing to find the tumor. If this procedure is too much for the patient, it may be completed after an interval of a couple of days, as has been successfully done. If the tumor cannot be successfully removed, the posterior nerve roots, at and just beyond the level of the tumor, should be divided. This, together with the removal of pressure by laminectomy, would afford great

relief to the patient. If for any reason the cord is to be incised this should be done exactly longitudinally.

The dura should be completely sutured with fine catgut in a round needle to prevent leakage of the cerebrospinal fluid. If a needle with cutting edges is used, I have found (Case II) that leakage may occur through the needle punctures. In only one case (Case V) a small drain of three strands of catgut was left through a small opening of the dura. Some [15] advise incomplete closure of the dura or none at all, to allow free drainage of cerebrospinal fluid. This I consider objectionable unless there is oozing of blood (as in Case V). I have seen the free drainage of this fluid accompanied by a restless irrational condition, which cleared up with the stoppage of the outflow of the fluid. Brodnitz has suggested that it was the cause of the rise of temperature in two aseptic cases and, according to Henle, the free outflow of cerebrospinal fluid has repeatedly been followed by a fatal termination, even without infection. It is always annoying and there is also more risk of infection and of a resulting spinal meningitis, and there is more difficulty in avoiding bed-sores when the back cannot be kept dry. If after the operation there is any evidence or suspicion of an increase of the tension of the cerebrospinal fluid, it may be relieved by lumbar puncture.

The muscles are brought together with interrupted chromic gut sutures to obliterate any dead spaces, and the thick aponeurosis with a continuous suture of the same material. At the lower angle of the wound a small drain of folded rubber tissue is inserted down to the surface of the dura to drain away any blood or serum for the first twenty-four to forty-eight hours. If a suture is tied to the outside end of this, it may be removed by pulling on the suture without disturbing the dressings. For the skin, a continuous buttonhole suture of silk answers well, but it should be reinforced by three or more interrupted, figure of eight, silkworm gut sutures through the skin and the edges of the vertebral aponeurosis, which are left in from twelve to fourteen days. This is for the reason that the skin edges are liable to separate,

after apparent healing and the removal of the silk sutures, allowing the wound to open up. This occurred in two cases (Cases II and V) in both of which there was some leakage of cerebrospinal fluid, apparently through needle puncture holes in the dura, as a Hagedorn needle was used in suturing. Whether this was due to delayed union on account of natural slow repair in this situation, or on account of trophic disturbances at the site of the wound, or on account of the constant watery discharges, or to the pressure of the body and the lateral strain in case of restlessness (as in Case V), it should be avoided by the use of reinforcing silkworm gut sutures, which may and should be left in longer than the silk sutures, or by substituting for silk horsehair sutures, which can be left in as long as desired.

In the course of the operation the question may arise whether the operation is to be completed in one or in two stages. In Case III we were compelled to suspend the operation after removal of the laminæ and exposure of an extradural tumor on account of the failure of the pulse and respiration. The patient responded to stimulation, artificial respiration and an infusion of 1000 c.c. of normal salt solution. The use of stimulating and nutritive enemata brought the patient into much better condition than before the operation, so that she underwent the second stage, forty-two hours later, much better than the first. In Case IV, the only fatal one in the series, the operation was long and very difficult, the tumor extending under the laminæ of six vertebræ and being very adherent and difficult to remove from the much compressed cord. I have often wondered whether the result might not have been different had we operated in two stages, though the post-operative condition was not entirely that of shock or collapse. The blood pressure, taken from time to time during the course of an operation, would give an indication as to whether the operation should be suspended and completed subsequently or not. The previous and present condition of the patient, the amount of blood lost and the length of time the operation has already lasted also help one

to decide whether to operate in one or two stages. There is a very decided advantage in completing the operation in one stage. The increased risk of wound infection alone is enough to decide the question in favor of the one-stage operation, if that is possible. Horsley has advised the two-stage operation in cases of brain tumor, but I do not advise it in intraspinal tumors,[16] as Brodnitz, as a routine measure, has done. As an occasional resort in difficult cases or those in poor condition it may be of life saving service. The wound should be temporarily closed. In case we operate in two stages shall or shall we not open the dura in the first stage? Unless the condition of the patient forbids it I would advise opening the dura in the first stage to learn the presence or position of the tumor and the direction in which it extends and to determine whether or what additional laminæ require removal at the second operation. In a recent case operated on in two stages by Dr. Elsberg the tumor appeared at the first operation on opening the dura very much like an intramedullary growth, but at the second operation, the pressure of the cerebrospinal fluid having been relieved for some little time, the tumor was well demarcated from the cord, facilitating its removal. Again in other cases the absence of a tumor might possibly be demonstrated, thus making the second operation unnecessary. The dangers of the opening of the dura, sepsis and excessive loss of cerebrospinal fluid, are preventable ones. It adds but little to the time or shock of the operation. The dura should be temporarily sutured to prevent the leakage of cerebrospinal fluid.

The *mortality* of the operation itself was found by Harte[15] in his series of ninety-two cases (including cysts) to be nearly 47 per cent. Among the ninety-six cases of operations on intraspinal tumors collected by Krause the immediate mortality (within the first twenty-four hours) was 10.4 per cent.; the mortality within the first week 20.8 per cent. and within the first three months 39.5 per cent. Krause gave the mortality 43.7 per cent., and in the last twelve cases 25 per cent. Among the seven cases operated on by the writer, the mor-

tality was 14.3 per cent. This does not include two exploratory operations and one case where the pressure on the cauda equina was due to an endothelioma of the upper sacral vertebræ, in all of which the dura was opened and in all the patient recovered. McCosh has stated that the mortality of laminectomy itself should not be over 10 per cent. Including these three cases the mortality was just 10 per cent.

The chief causes of death are shock and meningitis. The former can be reduced to a minimum by guarding against hemorrhage and operating in two stages, if the laminectomy is not well borne. The shock as a rule is not serious, less so than in operations on the brain. As meningitis is due to infection, it should be avoided by careful technic and the administration of urotropin. Infection is most likely to occur when a bed-sore is present. Hence the presence of the latter makes the prognosis more serious. A bed-sore should be carefully sterilized as described above. Especial care should also be employed in sterilizing the sound skin, in cases where a bed-sore is present, by the free use of Harrington's solution, or by tinctura iodi, used on a dry surface. The danger from the excessive discharge of cerebrospinal fluid is one easily avoided at the time of operation and subsequently by the use of the precautions already mentioned.

The After-treatment.—The patient should be placed at once on an air bed in the dorsal position. As soon as the patient can be moved without much pain, he may be turned on the side for the relief afforded by the change of position. The prone position employed by some is not necessary, neither is any special support for the spine. For the relief of pain in the back and limbs, especially on movement, or of painful cramps, morphine is necessary, perhaps for several days. To prevent the formation of bed-sores the back should be kept carefully clean and dry and if a bed-sore exists its discharge must be kept away from the wound. The latter must also be carefully protected from infection by the discharges from the bladder and rectum. In cases with paraplegia care should be exercised to avoid pressure sores and pressure paralysis.

Thus in Case II there developed a peripheral peroneal palsy, which was due to pressure either on the operating table or in bed. The lower extremities were at the time paralyzed in this case. The drainage should be removed early and the retention sutures left for at least ten to fourteen days. If there is leakage of cerebrospinal fluid this may be diminished and finally stopped by the pressure of a gauze pad over the line of the incision. If moderate in amount it will probably do no harm, even if it continues for some time, but besides being annoying it increases the danger of bed-sores and of sepsis, as long as it continues. Until the incision is healed, it is wise to continue the regular use of urotropin to keep the cerebrospinal fluid sterile.

After the operation patients should be kept in bed for at least three weeks as a rule, but this period varies from two to six or even ten weeks, according to the special conditions present. In some cases, especially in extradural growths and cysts, the convalescence may be very rapid and the necessary rest in bed equally short. Thus in Case III the patient went home fourteen days from the operation. After the disappearance of the pain and hyperæsthesia, massage is of great service in hastening the functional recovery. Electricity should also be systematically used for the same purpose. During the entire course of the after-treatment, the most scrupulous care should be employed in attending to the functions of the bladder and rectum if these are wholly or partly paralyzed. On this may depend the result of the case, and here is where the nursing art is put to its most severe test. It is quite possible to continue for a year or more with continual catheterization without infection of the bladder, but this is a monument to the skill and carefulness of the nurse. Fortunately most of these cases require catheterization for a relatively short time only, but if this is required at all it must be done with the most scrupulous care. Urotropin should be regularly administered during this period also.

Results.—The *immediate result* depends upon the position of the tumor (extradural or intradural), the duration and

degree of its pressure on the cord, and the amount of injury of the cord in the removal of the tumor, in spite of the greatest care. In general, immediately after the operation, there is a decided increase of the paralysis present before operation, especially the motor paralysis, and often a paralysis of parts not previously paralyzed. This is due not only to the slight traumatism to the cord, but also to the consequent œdema. In extradural tumors, this increase of paralysis may be nearly or wholly absent and in them the paralysis is usually promptly recovered from as in Case III, where improvement began on the second day and by the fourteenth all but the finer movements could be slowly performed. In intradural tumors the diminution of paralysis may not commence for two weeks, as in Cases I and II, or a considerably longer time, as in Cases V and VI. When once begun the improvement in motion is usually slow and gradual but may continue for a long time. When the pressure of the tumor has lasted a long time the improvement may be particularly slow. In a case reported by Warren,[17] improvement continued five years or more after operation. Of course if the pressure upon the cord has been severe or long continued enough to cause any degeneration, the muscles supplied by the degenerated cells or the cells connected with the degenerated fibres do not recover their lost power, as neither the cells nor fibres of the cord regenerate. The same also holds in the case of the degeneration of sensory fibres. Where there is no such degeneration the paralyses may be entirely recovered from even when they have been complete or nearly so. Those parts improve first and most rapidly which were last and least paralyzed and vice versa. This is a very strong argument for early operation on all intraspinal tumors. In most reported cases the results would have been better if the operation had been done earlier. Very little time should be wasted in trying antisyphilitic treatment, unless the syphilitic history is very definite. Of course even where extensive degeneration has occurred a successful removal of the tumor arrests the progress of the disease and saves life. The sensory disturbances improve before the motor.

Some pain may persist for a time from the disturbance of the posterior nerve roots, but as a rule the root pain is nearly always speedily relieved to a marked degree. In Warren's case mentioned before, the pain continued for six years, but this is most unusual. Directly after the operation there is often considerable hyperæsthesia but this soon disappears. Passive motion, and later active motion, of the parts paralyzed may for a time occasion severe pains. A spastic condition of the parts most or first affected may persist for a long time or even permanently, owing to a degeneration of fibres of the pyramidal tract, due to the long continued pressure of the tumor, or there may be merely a tendency to cramps. In these cases the deep reflexes remain exaggerated on the side or sides which had been paralyzed.

As to the *ultimate result*, this is favorable so far as my experience goes. Out of the six patients operated on (seven operations), one (Case III) being operated on twice on account of recurrence, none of the five who survived the operation have died as the result of the tumor, with the exception perhaps of Case VI. Although at the time of the second operation in Case III, an absolutely bad prognosis was given, I received a note from Dr. Mailhouse, November 3, 1909, over four years after the second operation, stating that the patient is practically well, doing her own housework, though she has a spastic condition of the left arm and leg due to degeneration of the pyramidal tracts produced by the long duration of the disease prior to operation, and she carries her head stiffly.

This result in spite of the fact that the microscopic diagnosis has usually been some form of sarcoma shows either that such tumors are relatively non-malignant within the spinal canal or that there is a mistake in the pathological diagnosis of these tumors. As an example the tumor in Case I was called a fibrosarcoma by one pathologist and an endothelioma by another. Many tumors formerly called fibrosarcoma are now called endothelioma and the distinction is largely a matter of terms. The length of time that had

elapsed in most cases from the first symptoms to the time of operation is against a high degree of malignancy of most of these growths. It is now quite generally recognized that endothelioma or fibrosarcoma is a form of tumor quite commonly found in the brain and cord, growing most often from the meninges, and showing but little malignancy. According to Starr, intraspinal tumors usually recur, but in nearly or quite half the cases of intraspinal sarcomata in Hartes' table of cases removal insured against recurrence, hence their recurrence is less frequent than that of similar sarcomata elsewhere. In my own cases, Case III recurred but did not recur again after a second operation and Case VI may very likely have recurred.

Except in the case of the thickenings due to a healed tuberculous process, the results of operations on intraspinal tuberculous foci are not so good as those from orthopædic and general treatment, for there is danger of recurrence or of setting up tuberculous meningitis, and the lesion is frequently an inoperable one in the cord. I know of no report of a successful removal of an intramedullary growth. As a result of the laminectomy the spine itself may be somewhat stiff in some cases, in others altogether normal.

The six patients on whom the seven operations were done, which form the basis of the surgical part of this paper, were all seen by Dr. Ramsay Hunt and the diagnosis confirmed or made by him. The first six operations have been published in The Transactions of The American Surgical Association, volume xxiv, 1906. They were all operated on in the Presbyterian Hospital.

Case I has also been published in the Medical and Surgical Report of the Presbyterian Hospital, volume vi, 1904, and in *The Medical News*, October 1, 1904. The first six and the eighth and thirteenth cases were operated on by Dr. Woolsey.

REFERENCES.

[1] Starr: Tumors of the Spinal Cord, Am. Jour. of Med. Sc., June, 1895.
[2] Collins: Spinal Cord Tumors, Med. Record, 1902.
[3] Schultze: Mit. aus dem Grenzgeb. der Med. u. Chir., 1903, S. 153.

[4] Oppenheim: Mit. aus dem Grenzgeb. der Med. u. Chir., 1905–6, S. 640.
[6] Bailey: Jour. Amer. Med. Assoc., 1910, p. 849.
[8] Oppenheim: Beitrag zur Diagnostik und Therapie der Geschulste im Bereich des Zentralen Nerven Systems. Berlin, 1907.
[7] Spiller, Musser and Martin: Univ. of Pa. Med. Bull., vol. xvi, 1901; Schmidt, Deut. Zeit. f. Nervenheil., Bd. xxvi, 1904; Krause, Berl. klin. Woch., 1906, No. 38.
[5] Oppenheim: Mit. aus dem Grenzgeb. der Med. u. Chir., 1905, vol. xv, S. 640.
[9] Auerbach-Brodnitz: Mit. aus dem Grenzgeb. der Med. u. Chir., Bd. xv, 1905.
[10] Mit aus dem Grenzgeb. der Med. u. Chir., vol. x, 1902, S. 673.
[11] Communication from Dr. Mailhouse.
[12] Reported by Dr. Hunt at a meeting of the N. Y. Society of Internal Medicine, January, 1906.
[13] Fraenkel and Ramsay Hunt: Medical Record, 1903, June 13.
[14] Crowe: Johns Hopkins Hospital Bulletin, 1908, vol. xx, No. 217, April, 1909.
[15] Harte: ANNALS OF SURGERY, 1905, xlii, p. 524, et seq.
[16] Centralblatt. f. Chir., Beilage, p. 37.
[17] Trans. American Surgical Association, 1905, p. 129, et seq.

INTESTINAL LESIONS PRODUCED BY BLUNT FORCE.

A REPORT OF FOUR CASES.

BY HARVEY B. STONE, M.D.,

OF CHARLOTTESVILLE, VA.,

Adjunct Professor of Surgery in the University of Virginia; Assistant Surgeon to the University of Virginia Hospital.

WITHIN the past two years there have been admitted to the University of Virginia Hospital four cases of intestinal injury belonging to the class variously designated as "traumatic" lesions, "subcutaneous" lesions, or, as in the title of this paper, lesions by blunt force. The distinguishing characteristic of such cases, familiar of course to all, is the fact that the visceral injury is produced without penetration of the abdominal parietes. Interest in the condition arises from this fact, as also from the comparative rarity of its occurrence and from the problem of successful treatment. That these cases may fairly be considered unusual is evidenced by the fact that most of the reports in the literature are of single instances met with in the experience of various authors, yet they are frequent enough to be far more important than mere surgical curiosities.

In many of the papers reporting cases, and in such reference books as Von Bergmann and Von Bruns' "Handbuch der Practischen Chirurgie," there are elaborate discussions as to the possible mechanism by which such lesions may be produced. Without rehearsing in detail these lengthy disquisitions, suffice it to say that three mechanisms are recognized as giving rise to these ruptures. The most frequent consists in a simple crushing of the gut between a colliding abdominal force and the underlying spine or promontory of the sacrum. The second described method is by bursting. A loop of gut containing fluid or air, and so kinked as to

be temporarily closed, is subjected to severe but unequal pressure, so that it explodes in the direction of least resistance. The third method, perhaps very rare, is by ripping loose of the intestines at their points of attachment, from a forced excursion of the movable parts beyond the limits of normal mobility. Thus the duodenojejunal and ileocæcal regions may be torn by the inability of these fixed parts of the gut to keep pace with the wider range of the small intestine, during rapid forced displacement. This mechanism may be likened to the way in which the cracker may be snapped off a whip. It occurs in falls from a height where the patient lands on the feet or buttocks. Certain particular accidents are prone to cause intestinal rupture, the more common being kicks or blows from the fist over the abdomen, falls from a height, striking flat upon the abdomen on an irregular surface, "run-over" cases, where the wheel passes across the abdomen or back, and crushing of the trunk between heavy objects. There are numerous rarer and some quite curious accidents which have led to the production of the lesion, one such being the forceful contraction of the abdominal muscles themselves.

From the stand-point of the severity of the lesion, cases are classified into contusions, ruptures of some of the coats, and complete rupture. There are authorities, notably W. Körte,[1] who consider contusions and ruptures of some of the intestinal coats as of importance, chiefly from the fact that such lesions frequently cause a later necrosis of the visceral wall and eventuate in a perforation. As Case IV of this series illustrates, there is another aspect of such lesions, namely the development of paralytic ileus from trauma to the intestinal coats in contusions and similar injuries. Further emphasis will be laid on this point later. Obviously the next development of all lesions which cause immediate or delayed perforation is the inception of peritonitis. In small ruptures this outcome may be delayed by the everted intestinal mucosa plugging the aperture. Such cases must be quite rare, and this conservative adaptation of nature is at best but tem-

porary. The nature of the peritoneal inflammation varies somewhat with the position of the lesion. Holes in the jejunum are less dangerous than those in the ileum, because of the relatively low bacterial count of the high intestine.

CASE I (Death).—Patient was a farmer, previously in good health, twenty-six years of age. Seventy-two hours before admission to the hospital he had been kicked in the abdomen by a horse. He immediately suffered intense pain and was so shocked that he had to be carried home. Pain continued without intermission, and with great intensity all over the abdomen, up to time of operation. Twelve hours after injury vomiting began, and continued at intervals. In spite of enemata and cathartics given by his physician, bowels had not moved since onset of trouble. Urine normal. On examination, patient had frank peritonitis, apparently general. There was distention, absence of abdominal respiratory movements, rigidity and tenderness everywhere, movable dulness in both flanks, and obliteration of liver dulness. There was perhaps an accentuation of the rigidity and tenderness in the right lower quadrant. Patient's condition bad. Temperature 103°, pulse 100, leucocytes 10,200.

A right rectus incision, rather low, was made, which immediately disclosed large quantities of free pus in the abdominal cavity. The ileum three feet above the ileocæcal valve was ruptured, the orifice being about 1 cm. in diameter. The abdomen was flushed freely with salt solution and a rubber tube placed in the hole in the gut, being secured by a purse-string and a retention suture. Counter-incisions for drainage were made in each flank; a drain was carried from the first incision to the pelvis, and the rubber tube in the gut was surrounded by gauze. The excess of the wound was hastily closed, patient leaving the table in very bad condition. However, his condition improved greatly after an infusion of salt solution containing 6 drops of 1 to 1,000 adrenalin to the litre. The next morning, temperature was 100.6 degrees, pulse 100, and general appearance good except for restlessness and distention. But in the afternoon, the temperature rose rapidly to 105.6 degrees and the pulse became very rapid and weak. This time there was no response to stimulation, and death ensued 42 hours after operation.

CASE II (Recovery).—Patient was a girl, previously healthy,

seven years old. She entered the hospital 36 hours after falling off a porch. She had struck upon her abdomen, on the angle of an upturned brick, such as frequently are set in the ground as a border about a flower-bed. Immediately after the accident the child suffered intense abdominal pain, and began to vomit within five minutes, continuing to do so until the time of operation. There had been complete constipation since the accident in spite of numerous cathartics by mouth. On examination, the condition was manifestly one of general peritonitis. Thighs were drawn up; abdomen rigid; general tenderness over abdomen; dulness in both flanks; liver dulness obliterated. Temperature 101.4 degrees, pulse 144. No point or area of especial tenderness.

A mid-line incision, the larger part of which was below the umbilicus, was made, and large amounts of free pus at once welled out. A careful search of the abdomen was begun at the ileocæcal valve, and no lesion found until the high jejunum was reached, where there was a rupture, about large enough to admit tip of index finger. The hole was ragged, with everted mucosa about its periphery, and situated near the mesenteric attachment. It was closed with a purse-string suture of catgut, which was reinforced by mattress sutures of the same material. This caused some narrowing of the lumen at the point of repair, but the finger invaginated into the gut above could be carried down through the constricted part without difficulty. A gauze pack was placed to the point of rupture and a liberal drain placed to the pelvis. Flanks were not drained. The wound was rapidly closed, and the child left the table in very bad condition, pulse being 168 per minute.

The patient was treated as are other cases of peritonitis. She was placed in the Fowler position, given salt solution per rectum, which was very well retained, and absolutely nothing by mouth. In addition, subcutaneous infusions of salt were given for the first 36 hours, at intervals of about 12 hours apart. Feeding was resumed very cautiously, rectal alimentation being relied on until the fifth day after operation. Vomiting continued for several days, but rapidly decreased in frequency. The general condition the day after the operation was much better, pulse falling to 110, and the temperature to 100.2 degrees. The bowels moved on the third day. From this time on the patient steadily improved, with occasional slight fluctuations. On the seventeenth

day the patient had another attack of vomiting, following an indiscretion in diet, which subsided promptly after an enema and restriction of food. On the twenty-second day the patient left the hospital entirely well. The wound discharged large quantities of fluid during the first 24 hours. As this diminished the drains were gradually removed, all the original gauze being out by the fifth day. The wound was entirely healed at the time of discharge from the hospital. This patient was recently heard from, six months after her injury, and she is entirely well and has gained considerably in weight.

CASE III (Recovery).—Patient was a farmer, fifty-one years of age, in fair health except for a right inguinal hernia of 14 years standing. Fifty hours before admission, the patient stumbled while walking on his farm, fell and struck his truss, over the inguinal region, against a rock. He immediately felt a sickening pain in the lower abdomen, and collapsed, so that he experienced great difficulty in going the short distance to his house. The pain continued in intensity and became general over the abdomen. Vomiting began several hours after the injury and persisted. There was complete constipation. On examination, the abdomen was found greatly distended; with slight general rigidity, most marked in the right lower quadrant; no dulness in the flanks; liver dulness obliterated. Tenderness everywhere, most marked in the right lower quadrant. Pulse 90 per minute; temperature 100.4 degrees, leucocytes 16,000. In the previous cases a definite diagnosis of peritonitis was made. In this instance, because the injury was so peculiar and because it was thought that at one time peristaltic waves were seen, the possibility of obstruction was considered.

A low right rectus incision was made, and at once gas escaped from the peritoneal cavity, and turbid fluid was discovered, especially in the pelvis, where there was quite an accumulation of pus. The appendix was normal. The intestine was then traced upward, and a foot above the ileocæcal valve was found an opening, opposite the mesentery, about 1 cm. in diameter. As this was pulled up fæces and gas escaped, as though the hole had become for a time occluded by the damaged loop sticking to another loop, or to the parietal peritoneum. The aperture was closed with fine black silk sutures. The pelvis and right lumbar fossa were drained through the original in-

cision, and packs were carried to the sutured spot in the bowel. A counter-incision was made for drainage in the left flank. The patient stood the operation well.

Second operation: Obstructive symptoms developed, and three days after the first operation it became necessary to do an enterostomy just above the point of rupture. The fecal fistula thus formed drained profusely, relieving the obstructive symptoms, but causing infection of the abdominal wall and extensive ulceration from the digestive action of the discharges. The patient meanwhile was passing some of his intestinal contents through the normal channels.

Third operation: After the patient had been relieved of several slight obstructive attacks by simple restriction of diet, the enterostomy was closed, three months after the first operation. The ulcerated area is now healing well and there is no leakage of intestinal contents. The patient is practically well, being about in a chair, and remaining in the hospital simply for convenience in having the healing wound dressed.*

CASE IV (Recovery).—Patient was a colored boy, fifteen years old, previously entirely healthy. While he was standing between an open gate and its gate-post, a cow had charged violently against the gate, crushing the boy against the post, and forcibly driving a part of the gate against the abdomen just to the right of the umbilicus. This occurred 101 hours before admission. Immediately after the accident, there was sharp abdominal pain, collapse, and free vomiting. The pain at this time was described as general over the abdomen, although most intense just to the right of the umbilicus. The attack of primary vomiting soon subsided, and there was no further vomiting,—a peculiar feature of this case. Distention increased gradually, constipation was practically absolute. There was no nausea to indicate reversed peristalsis. On admission, the clinical findings were as follows: abdomen greatly distended, but not rigid; no visible peristalsis; tenderness general but not marked; no

* This patient, Case III, died six weeks after sending this paper to press. At his death the surgical results were apparently entirely satisfactory. There was no fecal fistula, no obstruction, no peritonitis. So far as could be learned, death resulted from a general asthenia, the patient never becoming very strong, and the end coming quite suddenly and unexpectedly.

muscle spasm and no masses felt. On percussion, there was general tympany, and no movable dulness discovered. Pulse good, 110 per minute; temperature (rectal) 101 degrees, leucocytes 4,000. The absence of rigidity, free fluid, leucocytosis, or marked tenderness made against peritonitis, and hence against ruptured bowel. The absence of signs of hemorrhage pointed against rupture of the liver or kidney. A diagnosis of adynamic ileus from trauma was made.

First operation: A mid-line incision, chiefly above the umbilicus was made, and at once there was a gush of old blood. This was not very great in amount and was soon mopped out. There was no soiling of the peritoneum. The upper intestine, greatly distended, was picked up and traced downward. After passing down a number of feet, a loop was reached which presented marked signs of injury. There was no perforation, but over an area about 14 cm. long, the gut was contused, its serous coat ragged and rough, and the muscular wall infiltrated with old extravasated blood. This loop oozed when handled and was considered the source of the free blood above mentioned. Below this area the intestine was flat, collapsed, and empty, presenting a marked contrast to the distended condition above. A further search, hampered by the ballooned gut, revealed no other lesion. The injured area was 5 or 6 feet above the ileocæcal valve. An enterostomy was made immediately above the traumatized area of the intestine, a tube being inserted into the lumen of the gut.

Second operation: The tube placed in the intestine, as just described, never drained. The marked distention of the abdomen became even greater, but there was still no nausea nor vomiting. Apparently all peristaltic movement, normal or reversed, had been reflexly inhibited. Eserin and pilocarpin administered repeatedly in large hypodermic doses were without effect. Another operation was done, four days after the first, with the idea of relieving any possible kinking around the tube. No cause, other than lack of motive force, could be discovered to account for the lack of drainage. A solution of eserin (1 mg. to 2 c.c. of salt solution) was applied to the serous surface of a loop of dilated gut without causing any contraction whatever. To relieve the distention, a large amount of the gas and fecal contents of the paralyzed gut was mechanically emptied out. This time, in clos-

ing, instead of putting in a tube, the loop of gut already opened was packed outside the abdominal cavity in gauze. On the third day following this second operation, the enterostomy began to drain fecal material for the first time, on the eleventh day after the original injury. There was rapid relief of distention, and marked general improvement in the patient's condition.

Third operation: This consisted simply of the closure of the fecal fistula two weeks after the second operation. A resection, with lateral anastomosis, was performed, the only noteworthy feature of which was the difficulty encountered from adhesions. After this, the patient's convalescence was comparatively uneventful. He was discharged in very good condition, forty-three days after admission to the hospital.

In reviewing these cases one fact is especially worthy of emphasis. All four patients were brought in late in the history of the illness, the shortest intervening period since injury being 36 hours. The reason for such delay is in part explained by the fact that this hospital draws many of its patients from a widely spread rural population. Two important features of our cases depend upon this delay. In all of them, the development of abdominal and general symptoms had proceeded so far that the existence of a condition imperatively demanding a laparotomy was very manifest. If, however, the long interval following injury made the diagnosis and method of treatment matters of easy decision, for the same reason the successful prosecution of treatment was rendered all the more difficult. The experience of others lends weight to these assertions.

All authorities emphasize the difficulty in deciding upon the presence of a visceral lesion in the first hours following injury. In nearly all severe abdominal insults, whether or not they be associated with damage to the deeper structures, there is rapidly developing shock, usually associated with intense pain and vomiting. This condition may last for a number of hours. If there has been rupture of a hollow viscus, with ensuing peritonitis, the primary shock may merge into the latter condition without a perceptible demarcation. On the other hand, the symptoms of peritonitis may be delayed, appearing

some time after shock has subsided, and following an interval of marked seeming improvement. The difficulty of the situation in cases seen early is therefore quite evident. Is the patient simply suffering the symptoms inseparable from a severe contusion of the abdominal wall, or has he already passed from the primary shock of the trauma into the peritoneal disturbance following on ruptured gut? Or, again, the first severe upset from the accident has subsided somewhat; but is this to be a progressive return to normal, or is it merely an interval of quiescence before symptoms of a spreading peritonitis appear? The most important and difficult step in the handling of such cases lies just here. To wait for the development of distention, rigidity, the obliteration of the liver dulness, etc., is to throw away the great advantage of early intervention, before the general peritonitis, which causes these symptoms, has been established. Andrews [2] even advises against waiting for successive hourly leucocyte counts, and with wisdom. To overcome the difficulty various writers lay emphasis on various clinical observations. The cardinal symptoms of pain, tenderness, muscle spasm, shock, and vomiting may be quite as pronounced in severe parietal trauma alone as when visceral lesion is associated, hence subsidiary points have attracted attention in the effort to determine the presence of an injury to intestine, etc. Thus Munro, in Keen's "System of Surgery," cites Perez [3] as laying great stress on the value of continued, rapid and superficial breathing. In the same article, Mauclaire and Roger [4] are quoted as believing the injury to be serious when the muscle spasm and tenderness rapidly become general over the abdomen, and do not remain confined to the area of injury in the early hours after its occurrence. These points have failed however to impress the majority of observers with their importance. Indeed Bottomley [5] after analyzing an equal number of cases of abdominal injury, with and without visceral lesion, found that shock, pain and vomiting varied in individuals in the early hours, irrespective of the nature of the lesion, and that many cases could only be decided by exploration. In fact, this is the opinion of practically all recent writers on the subject, and

emphasis is laid on the necessity for exploring all cases of trauma of the abdomen by blunt force sufficiently severe to arouse the suspicion that the viscera have suffered. It is urged, and with reason, that the additional assault of the anæsthetic and exploration on a person already suffering from shock—who may not have internal injuries—is decidedly less to be avoided than the chance of permitting a ruptured gut to leak unrestrained, until it shall have given rise to sufficiently outspoken symptoms to make the nature of the injury evident. This necessity for exploration has not, we feel, been sufficiently impressed upon the medical profession in this country. The lack of appreciation of this necessity on the part of our patients' physicians is a decidedly more potent factor in the delay elapsing before they come to us, than is the number of hours travel that separate them from us. The difficulty of diagnosis is easily appreciated from the facts already presented, but this difficulty in itself should make all the more evident the wisdom of immediate consultation with a surgeon and exploration in most instances.

Cases which are seen somewhat later usually are easier to diagnose. The persistence for hours of vomiting, or its recurrence after an interval of cessation, is an important indication that there is more than a superficial contusion. The same is true of the persistence and increase of rigidity, tenderness, and distention. When these findings are supplemented by obliteration of liver dulness, fluid in the flanks, fever, leucocytosis, etc., we have of course an unequivocal picture of peritonitis, which with the history of trauma, makes the diagnosis of subcutaneous rupture of a hollow viscus almost certain. The only other condition which could cause doubt would be the rupture of some parenchymatous organ, like the liver or spleen, with hemorrhage into the abdominal cavity. Such a lesion would usually be associated with anæmia, restlessness, thirst, low red corpuscle count and the other signs of concealed hemorrhage. The two lesions are so closely related in their cause and treatment, that they may really be considered as belonging to the same class of cases, and therefore not further discriminated.

In those cases seen later, the treatment is the same as in the group of early cases previously discussed; namely, exploratory laparotomy. The difference lies only in the fact that the indications for operation now are much clearer, the operative procedures required more difficult and time-consuming, and the prognosis much more grave. To the general statement that all these cases should be operated, there is but one exception; namely, where the patient is already moribund. Even here refraining from operation should be carefully considered, because as Case 11 reported in this paper and experience with peritonitis of other origin in many other instances has shown, the rule of never giving up hope is a pretty good one. At any rate the operator gives his patient the benefit of a chance by interfering, whereas such a case left to nature is equivalent to an admission of defeat.

The chances for a successful termination without operation are practically *nil;* with operation, the chances vary inversely with the period intervening between the receipt of injury and the time of intervention. Thus Petry[6] collected 42 cases, of which 18 were operated in the first 24 hours, with success in 44.5 per cent.; whereas of the remaining 24 cases operated later than 24 hours, 75 per cent. were lost. A summary of Brunner's statistics shows that within the first 10 hours a majority recover; from 10 to 20 hours, the chances are even; and after 20 hours there is a rapid increase in the percentage of cases lost. It is admitted that this probably represents too favorable a view of the results, as more successful than unsuccessful cases are apt to be reported and collected. The force of this stricture is seen by comparing Brunner's figures with those of Berry and Giuseppi[7] collected from the records of 10 London hospitals for a period of 15 years (1893–1907) and embracing in all 132 cases. Of these, 48 cases were not operated and all died. Seventeen of 84 cases operated were saved, 12.8 per cent. of the total number of cases. No case recovered when operated upon more than 28 hours after injury, and only two when operated more than 12 hours after injury. These figures speak with sufficient eloquence for the importance of early operation. It

will be noted that the latest of our peritonitis cases died, and the earliest made the easiest recovery.

There is, of course, another factor in the question of mortality than the simple one of time, and that is the value of the therapeutic measures invoked. The great improvements inaugurated in the last few years in the treatment of general peritonitis show their effects very clearly in this group of cases. These improvements are familiar to the entire surgical world as the Fowler-Murphy method, and may be summarized briefly as the elevated posture, the rigid restriction of everything by mouth, and the administration of fluids in small amounts and at frequent intervals per rectum. We feel that to this we owe the recovery of two of our cases long after the deadly time-limit of 28 hours of Berry and Giuseppi. That this is probably true, is further suggested by finding other successful late cases (Legnani,[8] Poncet[9]) in the literature of the last three years.

The repair of the local damage depends upon its extent. A small hole is best closed by sutures; a large lesion may be best handled by resection and anastomosis, if the patient be received early and in good condition; otherwise by enterostomy. This is really a matter of subsidiary importance, provided its execution is not so difficult mechanically as to prolong the operation unduly. The essential question is the successful treatment of the peritonitis, the extent of which depends largely on the duration of the condition. In all of our cases it was quite general. It is our practice to drain the pelvis, the site of the lesion after its repair, and sometimes the lumbar fossæ. Then the patient is put almost upright in bed, rectal administration of normal saline solution is started, and usually a subcutaneous infusion. The weight of authority, in all but some of the recent publications, urges the use of free irrigation of the abdominal cavity with sterile normal salt solution in large amounts (30–50 litres). It is the experience of this clinic that better results are obtained without such irrigations, unless there be gross soiling with fæces, undigested food, etc. It may seem unnecessary to protest against the giving of cathartics to these patients, but our cases testify to the con-

trary. In the second case, a number of doses of salts escaped promptly through the perforation in the jejunum, and were found along with many other things in the pelvis. As to the convalescence, there is nothing requiring remark as different from that of peritonitis cases in general, except to point out that some vomiting is to be expected, perhaps for a number of days, and that one should be on guard against a secondary obstruction.

So far, this paper has consisted chiefly in a consideration of the possibilities resulting from rupture of the intestine. Three of our four cases involved this lesion, and the great majority of reports in the literature are of such injuries. Our fourth case presents certain interesting features which are deserving of individual comment, best made in separate paragraphs from those devoted to a consideration of rupture. Although the etiological factors of intestinal contusions, such as Case IV presents, may be identical with those causing rupture, and indeed a contusion may later become a perforation from the necrosis of the injured areas, nevertheless the clinical picture and necessary treatment of such a case as Case IV presents distinct differences from Cases I, II and III. The pathological development, in the two groups, of course proceeds along very different lines. With the establishment of a rupture, peritonitis ensues; there follows inevitably the evidences of the local inflammation with the constitutional signs of rapid toxic absorption. When a contusion, as in our last case, causes a local paralysis of the intestinal musculature, with a consequent ileus, there follows naturally the syndrome indicative of obstruction. It would be a work of supererogation to elaborate here the typical descriptions of peritonitis and intestinal obstruction. The slower development, lower leucocyte count and better general condition of the patient in obstruction will usually help in the diagnosis as well as the local differences in abdominal signs and symptoms. But while it is possible that some obstruction cases arising from blunt intestinal contusions may present the typical appearance, ours certainly did not. Nausea and vomiting, most characteristic features of obstruction, were strikingly absent after the first

hours. The allied symptom of sharp colicky pain, and the accompanying sign of visible peristalsis were also not discovered. These peculiarities occasioned some difficulty in making a diagnosis, but in looking back over the case, it would seem highly probable that the contusion of the gut not only caused a direct paralysis of the area damaged, but also resulted in a reflex suppression of peristalsis throughout the small intestine. In no other way is it easy to explain the curious clinical symptoms and operative findings. The wonderfully good condition of the patient during the long interval of adynamic obstruction (ten days in all) is worthy of comment. So also is the utter failure of the administration of pilocarpin and physostigmin to reëstablish peristalsis. With the renewal of this function the case presented then simply the common problem of closing a fecal fistula.

Although rupture is more frequent and results in a more fulminant disturbance, the occurrence of paralytic obstruction from blunt force presents essentially the same problem. That is to say, such lesions demand, in our opinion, exploratory laparotomy and the appropriate handling of the obstruction. In early cases, with active peristalsis above the damaged loop, a lateral anastomosis, with resection of the injured area, is perhaps indicated. In an instance such as ours, of four days standing and with no evidence of muscular action in the gut, the requirement would seem to be immediate establishment of an enterostomy, with the mechanical removal of as much gas, fecal matter, and intestinal secretion as possible. One very definite result of this procedure is to relieve the great distention of the obstructed bowel, which contributes much toward aiding the return of peristalsis. This relief of tension is in itself sufficient argument against the view which some might advance, that nature should be left to take care of the case. Admitting that the contusion may subside and the damaged loop once more take up its function and thus relieve obstruction, it is very doubtful if this would occur were the overdistention not relieved.

In conclusion, there are a few details concerning these injuries, which should be mentioned for the sake of complete-

ness. These accidents are most frequently met with in males during youth and early manhood, and in females during childhood, these of course being the periods of greatest exposure to trauma from the habits of life. Preëxisting lesions, such as hernias, ulcers, adhesions, etc., of course increase the liability of rupture should trauma occur. Our third case is an illustration of this statement. Lax abdominal muscles afford less protection than a wall which is contracted, and hence very sudden accidents are more frequently the cause of visceral lesion than those in which the patient has some warning. All parts of the gastro-intestinal tract have been injured, to say nothing of the other abdominal viscera, but the ileum and jejunum are more often involved, the colon and stomach less frequently. Thus in 219 cases, the small intestine was affected 172 times, the large 26 times and the stomach only 21 times. Lesions of course may be multiple, or may be associated with rupture of other organs. We are inclined to feel that vomiting is apt to arise sooner if the lesion be above the level of the umbilicus than if it be below. Thus Case II began to vomit almost immediately, whereas in Case I and Case III there was quite a pronounced interval before vomiting commenced.

BIBLIOGRAPHY.

The bibliography of this subject is exceedingly voluminous. Only papers referred to in this article are tabulated here.

[1] Körte: Von Bergmann's "Handbuch der Practischen Chirurgie."

[2] Andrews: A Study of Five Cases of Subcutaneous or Concealed Rupture of the Intestine Treated by Laparotomy. Surg., Gynec., and Obstet., Chicago, 1906, ii, 608.

[3] Perez: Arch. Intern. Chir., 1905.

[4] Mauclaire and Roger: Bull. et Mém. Soc. Chir., t. 27.—Contusions.

[5] Bottomley: Boston City Hosp. Reports, 1901.—Abdom. Contusions.

[6] Petry: Ueber die subkutanen Rupturen and Kontusionen des Magens und des Darms. Beitr. z. klin. Chir., 1886, xvi.

[7] Berry and Giuseppi: Traumatic Rupture of Intestines, with a Case of Recovery after Operation, and an Analysis of 132 Cases, etc. Proc. Roy. Soc. Med., London, 1908–9, ii, Surg. Section.

[8] Legnani (T.): Un caso di peritonite purulenta acuta diffusa da rottura sotocutanea del tenue; operato con successa 52 ore dopo la lesione. Bull. del Soc. Med. Chir. de Pavia, 1908, xxii, 267.

[9] Poncet: Contusion de l'abdomen; perforation intestinale; enterectomie au 4e jour; guérison. Lyon Méd., 1907, cviii.

TRANSGASTRIC JEJUNAL FEEDING.*

AFTER GASTRO-ENTEROSTOMY COMBINED WITH GASTROSTOMY. TESTED IN A CASE OF ARTERIOMESENTERIC ILEUS.

BY ARNOLD SCHWYZER, M.D.,

OF ST. PAUL, MINN.

THE problem of feeding a patient suffering from a very vulnerable open gastric ulcer has many a time been under discussion and the advice to resort—in a desperate case—to a jejunostomy had remained as the only help, though little satisfactory, first because an external fistula of the small gut has the tendency to very troublesome leakage (a point which, however, can be avoided by a good technic); second, dangerous adhesions and kinks in the bowel may be formed; third, a speedy emptying of the acid gastric juices, the most important element for the cure of the ulcer, is not influenced by it; and finally, on account of this latter an operation must follow later on in most of these severe cases. It may be said, however, that when the food is taken by mouth in the normal way, the gastric juice is by far more freely secreted than by any other ingestion. In extragastric feeding HCl is therefore to be expected only to a moderate amount in the stomach. Experience has taught, that in the long run feeding by a gastrostomy fistula is mostly insufficient, and that the patient slowly loses ground by it. It can thus be concluded that by jejunal feeding the nutrition suffers much more, because the presence of chyme in the duodenum is of great importance for the secretion of the pancreas. A jejunal fistula can therefore only be of great use when we have to tide the patient over a starvation of a number of weeks, but there it does infinitely more than rectal feeding. I had concluded that in a case of

* Read before the Western Surgical Association, Omaha, Neb., December 20, 1909.

severest gastric ulcer, where gastro-enterostomy and in addition a jejunostomy seem desirable, a better result could be obtained by a modification of these operations for drainage and for extragastric feeding. This modification I had a chance to try in a case of duodenal obstruction with a most rebellious stomach. This patient does not exactly belong to the group of cases spoken of, but shows the possibility of usefulness of this procedure in different conditions. The case is through a number of rarer occurrences interesting enough in itself to be related in detail.

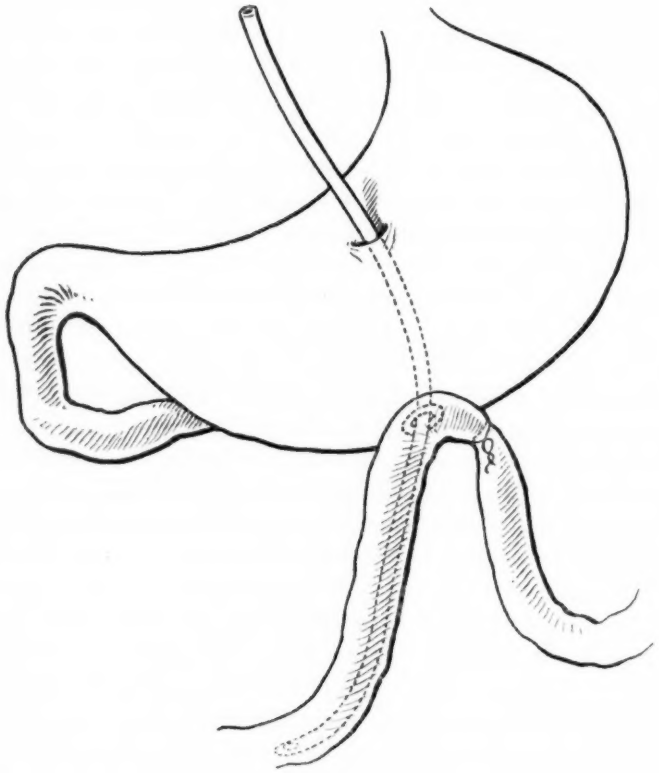
Sr. S., nurse in charge of one of the floors at St. Joseph's Hospital, aged 23 years, who had been in splendid health up to the end of 1907, began to look thinner after that time. She was suffering from very little pain but could not eat solid food, and during February and March, 1908, was living practically only on buttermilk and even had to gradually reduce the quantity of this latter.

On April 6, 1908, I first saw her, and she remained under my observation until April 23. During this time there was frequent vomiting, and at times the vomitus contained blood. Abstinence from food lessened the amount of vomiting but did not produce complete cessation. The blandest ingesta in minutest amounts were vomited up very shortly after being taken. The pulse ranged from 50 to 80; temperature, from 98 to $99^{3}/_{5}$. All suggestions of surgical interference were rejected until April 23, when permission to operate was granted. Preliminary to the ether narcosis, one-sixth grain of morphine with $^{1}/_{150}$ gr. atropine was given hypodermically. On opening the abdomen the stomach appeared slightly ballooned, and also the upper duodenum, the pyloric ring being wide. At the lower end of this dilated part of the duodenum a broad, very firm band of adhesion unites the duodenum with the gall-bladder. The tense gall-bladder is found to contain small stones. The gall-bladder was dissected free. The lower ducts were normal. A drain in the gall-bladder was led out through a stab wound in the right border of the ribs. Air pressed through the lower duodenum by compressing the stomach seemed to pass. The experiment, however, is not beyond doubt. Further exploration of the abdomen revealed an adhesion

of the omentum to the abdominal walls at a point a little below the level of the spleen. This adhesion was divided. The bulk of the omentum was fixed in the pelvis and could not be moved upward, as if broadly adherent. The abdominal walls were tightly stretched and pressed toward the vertebral column (the narcosis then not being complete). We were struck by the lack of space anteroposterially in the umbilical region. After forcible forward retraction of the abdominal walls the omentum was gradually drawn out of the pelvis. It was not adherent but was very bulky. The transverse colon was long and large and had also been lying below the promontory. The small intestines were entirely collapsed and contracted. The condition suggested arteriomesenteric ileus. The omentum was brought into contact with the wound and one stitch caught it in the lower angle to hinder its returning to its former position. The abdomen was now closed. Right after the operation the respirations were 12; pulse 88. Two hours afterward the respirations had slowed to 8 per minute, and soon afterward to only 4 per minute. Next morning pulse weak and irregular—122. Vomiting became continuous and considerable blood was noticeable in the vomitus. The vomitus was composed of liver and pancreas secretions.

I determined now to combine a gastro-enterostomy with gastrostomy and pass a gastrostomy tube through the opening in the anterior wall of the stomach and across the stomach through the gastro-enterostomy opening some distance into the jejunum. By the use of a rather large Murphy button a rubber catheter could be passed through its opening into the lower arm of the jejunal loop, and since this catheter would nearly but not tightly fill the lumen of the button the tendency would be to retain the infused food in the intestine, though some drainage was possible along the tube and through the side walls of the button for the gastric and other regurgitated secretions. In accordance with these purposes the wound was reopened. The omentum again seemed to be down into the pelvis. It was raised up, and with as little eventration as possible the first part of the jejunum was secured and an antero-inferior gastro-enterostomy was done, the smaller half of the button being inserted into the stomach. Then a good distance from the gastro-enterostomy opening a tiny opening was made into the stomach wall, just enough to make it possible to force a soft catheter through, which was however

rigid enough so as not to double up too easily, and thus not to have its jejunal end eventually expelled back into the stomach by the collection of a greater quantity of food in the gut. This catheter was brought out through the gastric half of the button, then inserted into the lower half, and now the button was closed. The catheter was pushed in far enough to reach about 10 or 12



cm. beyond the button into the lower loop of the jejunum.[1] The button seemed a little large for the gut, and therefore in order to support the line of union a continuous silk Lembert suture was applied over the two anterior thirds of the circumference. Two silk pucker-strings inverted the stomach walls around the catheter,

[1] If instead of the button I had used the suture method the tube would better have been pushed even farther down into the jejunum and a very thin and soft tube would have been preferable.

the inner one catching the catheter, the outer one being fixed to the fascia of the abdominal walls, which were now closed by figure of 8 silkworm sutures.

The operation, including the closure of the wound, took 35 minutes. Before taking the patient from the operating table 12 ounces of thick malted milk were administered through the tube into the jejunum and coffee and water per rectum. The pulse shortly before the operation was 132, the respirations 8 per minute. After the operation the pulse was 144; respiration 5. Half an hour later the respirations were 4 per minute; then at 10.30 P.M. only 3 and at 10.45 only 2 respirations were observed per minute. Some blood was then vomited. Every hour 3 ounces alternatingly of strong malted milk and beef tea were given into the jejunum. In the night the temperature went up to $101^2/_5$ by axilla, but after a very heavy sleep it was evident by morning, that oil had been added to the lamp. The next day, April 25, at 8 A.M., pulse 110; respirations 7 per minute. Now a new trouble came. At 11 A.M. the patient began to complain of very severe pain and vomited a large basin full of dark green fluid with apparently a very small quantity of the injected food. An hour later again such copious vomiting and very frequently during the afternoon, so that the feeding had to be stopped. The gall-bladder drainage yielded only very little bile. Late in the evening after severe pain in the stomach again a large amount of dark green fluid was vomited. The pulse however had come down to 93; the respirations were 13, and the night was good.

The next morning (April 26) we tried to counteract the vomiting in assisting drainage by having the patient repeatedly sit up for 10 minutes with a back rest, though she was extremely weak. The copious vomiting, however, of greenish fluid kept up. No particles of food were seen in it. It was evident that we had the picture of acute dilatation of the stomach with that well-known abundant secretion into the stomach; this picture was however previously modified by the prompt vomiting and now by our drainage. Could for such cases the cause lie simply in an obstruction of the lower duodenum, the copious fluids being perhaps only moderately increased or even normal quantities of stomach, duodenum, pancreas, and liver secretions combined? The quantity of these four secretions has been found to be much larger than we formerly thought, and to be nearly equal in 24

hours to the individual's volume of blood and lymph together. Stomach washing relieved the patient greatly for some time. The jejunal feeding is kept up, but hardly any pressure allowed. The fluid in the irrigator is kept at a level with the pit of the stomach. For a larger feeding one hour is often required, and no food is administered if after removing the clamp on the feeding tube there is escape of any amount of the formerly ingested food. There is however no discharge of malted milk from the tube one hour after giving 4 ounces, while one-half an hour after the feeding a little appears on removing the clamp. Cream is added to the malted milk. Either the stomach has very poor contracting power or stomach contents, slime, etc., have blocked the small amount of space left in the Murphy button, or both factors combine to the effect that apparently all the secretions in the stomach must be washed out or vomited. Cascara with the feeding causes several defecations. The feeding through the catheter becomes severely distressing; the nausea, vomiting and weakness produce again a very miserable condition.

I then inserted on the third day after the second operation a stomach tube and removed about 10 ounces of bile-stained fluid. Considering this to be digestive secretions it was now mixed with 7 ounces of thick malted milk, 3 eggs and some salt and was infused into the jejunum. The same was done in the evening of the same day and twice the next day. This seemed to produce a very favorable change. Four and a half days after the second operation the patient was given buttermilk in sips by mouth and retained it all. The feeding, mixed with the gastric secretions, was kept up twice daily. The tube leading to the gall-bladder was removed on May 4. The patient had by this time begun to complain so much, that feeding in any way became almost impossible and had to be greatly reduced. On May 6 the pulse ran high, up to 160 and 168 with a temperature of 101. The patient was most dilapidated, wanted to be left alone to die. We feared that the comparatively large button made part of the trouble, large quantities of blood having appeared in the stools, but it seemed necessary that the feeding be pushed. One quart of cream and milk, 3 heaping tablespoonfuls of sugar were then given by the tube and at the same time the stomach washed and a moderate regurgitated portion of the feeding thus removed. This was repeated every 8 hours.

The next day pulse very weak—130 to 150. Feeding kept up. When food was vomited, it was given again by the tube. On May 10 she began again to eat a little. On May 11 she was taken out into a chair. On May 12 she ate so nicely that feeding through the tube was omitted. The patient was from then on up every day and began to feel better and gradually stronger. The tube was removed from the stomach 3 weeks after the operation; the button did not pass until 60 days after the operation. This I think was due to its large size. The first weighing 8 weeks after the operation, gave 88 pounds, while the patient had weighed 156 pounds before the sickness.

Now, one and a half years after the operation, the patient is looking well, weighs 121½ pounds, has no complaints except that, when she was greatly overworked, she vomited a few times. She is again in charge of one of the hospital floors.

Contrary to Laffer's views in the ANNALS OF SURGERY (March and April, 1908), arteriomesenteric ileus has to be considered as an established pathological condition. Two elaborate publications in support of this have appeared this year: Nakahara's, from Enderlen's clinic in the *Beiträge zur klinischen Chirurgie,* Bd. lxiv, Heft 1, and lately V. Haberer's from V. Eiselsberg's clinic, in the *Archiv für klinische Chirurgie,* Bd. lxxxix, Heft 3. Haberer in reviewing the literature says, that no case, where all other means were fruitless and where therefore surgery had to be resorted to, had as yet survived.

It may be that this combination of gastrostomy with gastro-enterostomy and transgastric jejunal feeding will be of use in some of these and similar conditions.

After the gastro-enterostomy is done, the additional gastrostomy with the insertion of its tube into the jejunum is of course a very simple affair and adds certainly much less to the operative trauma than the somewhat bulky title of the paper would lead us to presume.

THE PROPOSED FISTULO-ENTEROSTOMY OF VON STUBENRAUCH.

BY WALTER S. SUTTON, M.D.,

OF KANSAS CITY, MO.

Assistant Professor of Surgery, Kansas State University.

It has doubtless been the experience of most surgeons of large practice to meet one or more cases of persistent post-operative biliary fistula in which the conditions known from the preceding operation argued against the success of a secondary cholecystenterostomy or choledocho-enterostomy. Numerous procedures have been proposed for the relief of this distressing condition, the most promising of which are the fistulo-enterostomy of V. Stubenrauch [1] and the choledocho-plasty of Sullivan.[2] Neither of these has been tried by its author on the human subject, though both have given promising results in animal experiments.[3]

It has been the author's pleasure to follow a case on the service of Dr. J. F. Binnie in which the V. Stubenrauch procedure was carried out. Since, so far as we have been able to ascertain, this is the first application of the method to the human subject, it has been deemed advisable to publish this brief description of the operation and its results.

The patient, a woman of fifty-seven years, came to operation because of persistent and progressive jaundice, coupled with digestive disturbances, loss of weight, and tenderness over the

[1] V. Stubenrauch: Ueber plastiche Anastomosen zwischer Gallenwegen und Magendarmcanal zur Heilung der completen äusseren Gallenfistel. Arch. fur klin. Chir., lxxix, 4 S. 1025, 1906.

[2] Sullivan, A. G.: Reconstruction of the Bile-ducts, Journal A. M. A., Sept. 24, 1909, vol. liii, pp. 774–777.

[3] Since the preparation of this article, Dr. Geo. E. Brewer has reported a case in the human subject in which the method of Sullivan was used with at least temporary success. Brewer, Geo. E.: Hepaticoduodenal Anastomosis, ANNALS OF SURGERY, li, 6.

gall-bladder region. The usual incision exposed a long Riedel's lobe extending far below the normal hepatic margin, and under this a green, slightly thickened gall-bladder, showing a moderate number of adhesions to the great omentum and hanging well down toward the pelvis. The gall-bladder was opened and a considerable quantity of tarry bile was evacuated. The common duct, which was larger than the forefinger, also contained tarry bile but no stones. This was opened to facilitate exploration and a tight stricture was found in the lower part, due to a tumor of the head of the pancreas. There were no enlarged glands in the neighborhood and the condition was regarded as chronic pancreatitis. The abdomen was therefore closed with gall-bladder and choledochus drainage. The tubes were removed in about a week, after which one of the sinuses rapidly closed while the other—later proving to be the gall-bladder drain—continued to discharge a good quantity of normal bile. The jaundice gradually disappeared but the stools remained acholic. At the end of four weeks this was still true, and the patient was told that the biliary discharge from her abdominal sinus would probably be permanent. This caused her great distress, and she expressed in strong terms a desire to have the benefit of any procedure which might offer her relief. It was therefore decided to try the efficiency of the proposed procedure of V. Stubenrauch, which uses a diverted segment of gut as a canal to carry the discharge from a biliary fistula back into the intestinal tract.

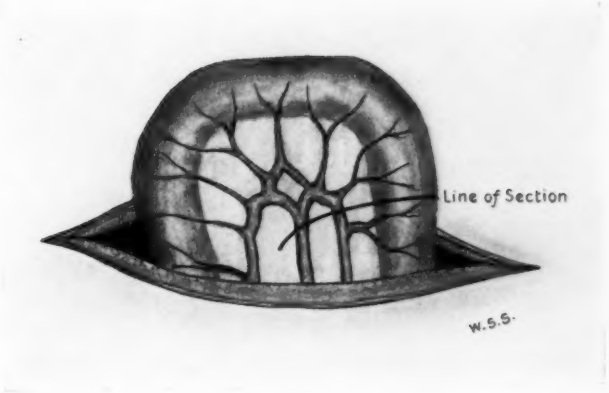
The operation was as follows: The abdomen being opened by means of a vertical incision below and slightly median to that of the first operation, a loop of ileum about eight feet from the cæcum was picked up and brought out through the wound. This was divided between clamps in the usual manner, the incision being carried into the mesentery for about three inches in such a direction as to preserve the blood supply of both portions of gut (Fig. 1). The proximal end of the distal segment was inverted with a temporary purse-string while the distal end of the proximal segment was united end-to-side with the distal segment, as far as possible from the line of section (Fig. 2). The mouth of the fistula was then cleaned as thoroughly as possible and its edges excised. A subcutaneous track was burrowed in the superficial fat from the upper extremity of the wound to the opening of the fistula; and through this was drawn

the blind end of the diverted gut-segment (Fig. 3). This free end was allowed to protrude a short distance and was tightly tied with a strong ligature so that it might slough open in the course of a few days. The operative wound was closed without excessive pressure on the emerging gut-segment.

Three days later the protruding gut was cut away—a proceeding which was accompanied by free arterial bleeding, thus testifying to the good condition of this portion of the gut. Later in the same day a rubber tube was inserted—one end in the biliary fistula and the other in the subcutaneous segment of intestine—being safe-guarded from passing entirely into one or the other of the passages by an attached thread. The following day the patient passed a bile-stained stool. Six days later—nine days in all after the operation—the rubber tube was removed, and the edges of the fistula freshened and undermined for a short distance and then brought together. Three days later this last wound reopened and discharged *bile* and *fæces*.

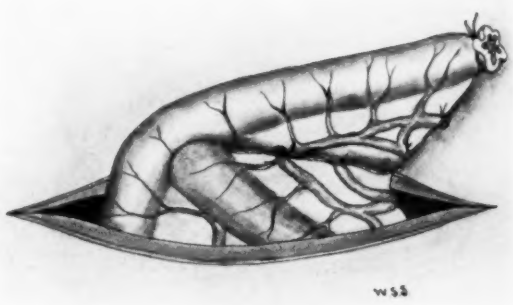
This discharge continuing and remaining unchanged in character, it became plain that the attempt was a failure and that the fecal fistula must be closed. Accordingly, 26 days after the operation the patient was again taken to the operating room, the subcutaneous limb of gut exposed and freed. It was found only lightly adherent with its peritoneal coat preserved and glistening, though that portion of the mesentery which supplied it was more firmly united to the surrounding tissues. This portion of the intestine was removed close to the anastomosis and the open end closed and inverted. Palpation through the wound showed the tumor of the head of the pancreas markedly larger than before and gave indication that the biliary fistula consisted of the gall-bladder itself and not of the track of the choledochus drain as there had been some reason to suspect. This latter was confirmed by exposure of the fistula for a short distance. The gall-bladder was found to be shrunken, much thickened and firmly adherent to the neighboring structures on all sides. With great difficulty it was freed as far as the cystic duct. The second portion of the duodenum was mobilized by separation from the posterior abdominal wall along its right margin and the trimmed opening of the gall-bladder united with this by means of a Murphy button, supported by some reinforcing sutures. Closure of the abdomen

FIG. 1.



Method of dividing mesentery of loop of ileum. (After sketch by Dr. Binnie.)

FIG. 2.



End-to-side anastomosis of proximal into distal segment of divided gut. (After sketch by Dr. Binnie.)

FIG. 3.

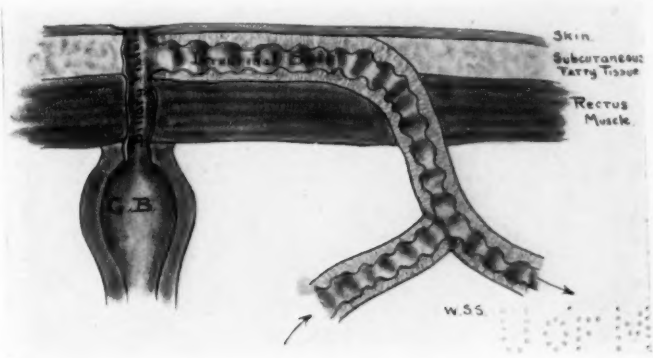


Diagram of relations of gut, fistula and gall-bladder as established by operation of V. Stubenrauch. (After sketch by Dr. Binnie.)

was made with drainage to the site of the anastomosis. There was little drainage and the tube was removed on the third day. The patient improved in color and strength and even gained weight. The button was passed on the thirty-seventh day after operation.

This result shows that while the proposed operation of V. Stubenrauch is perfectly feasible as a problem in human architecture, it is a failure on physiological grounds. The diverted segment of gut in some cases at least will fail to exhibit sufficient peristaltic activity to prevent the back-flow through it of intestinal contents. Whether this is due to the absence of the impulse to contraction normally imparted to each segment by the one immediately above it in the act of peristaltic contraction, to the fact that any narrowing of the lumen in the subcutaneous portion of the gut is resisted by the adhesions to the surrounding tissue, to interference with the sympathetic nerve supply coming through the mesentery, or to a combination of all these factors, we must leave it to the experimental physiologist to determine.

PERMANENT COLOSTOMY.*

AN IMPROVED ORIGINAL OPERATIVE METHOD.

BY HOWARD LILIENTHAL, M.D.,

OF NEW YORK,

Attending Surgeon to Mount Sinai and Bellevue Hospitals.

THE formation of an artificial anus for the permanent relief of obstruction of the lower bowel is regarded by most surgeons as a loathsome makeshift for the prolongation of life. The mental picture of such an opening suggests the constant uncontrollable discharge of fæces and flatus, the painful and annoying dermatitis in the neighborhood of the exposed mucosa and the necessity for constant change of dressings—in short, a condition of actual and permanent disability for the ordinary duties and pleasures of life. Various forms of apparatus—valves, obturators, etc., have been devised for holding the discharges in check, all more or less uncomfortable to the patient and all inefficient in action.

For at least eight years I have been performing an operation which obviates nearly all the discomfort and filthiness of colostomy. The patients have absolute control of the bowels and can even hold a considerable quantity of fluid injected into the colon. The bowels move once or twice a day, the patient knows when the movements are about to occur and—not by any means the least advantage—he is not annoyed by the necessity for wearing an appliance for obturation. The operation has been tested many times and the patients have been for the most part carefully followed up. A description of the steps of the operation follow:

An incision about 3½ inches long, more or less, is made over the outer third of the left rectus muscle and parallel with its fibres. The upper end of this incision is just about on a

* Read before the Section on Surgery of the New York Academy of Medicine, April 1, 1910.

line between the umbilicus and the left anterior superior iliac spine, but the exact length and location of the wound depends somewhat on the amount of subcutaneous fat present. Through this incision the fingers explore the abdominal organs and the type and limitations of the stricture or tumor are learned. The sigmoid flexure, be it well developed or not, is drawn out. As is well known, this part of the intestine varies greatly in length, but all is taken out which can be withdrawn without tension. The two legs of the loop are separated as widely as possible, the upper leg being sutured to the peritoneum and posterior rectus sheath in the upper angle of the wound, and the lower is sutured in a similar manner to the inferior angle. Silk or linen thread is the suture material, and the stitching is done by the continuous method, every third stitch being tied so as to avoid purse-stringing. The mesosigmoid is now sutured through and through to the peritoneum on each side (Fig. 1).

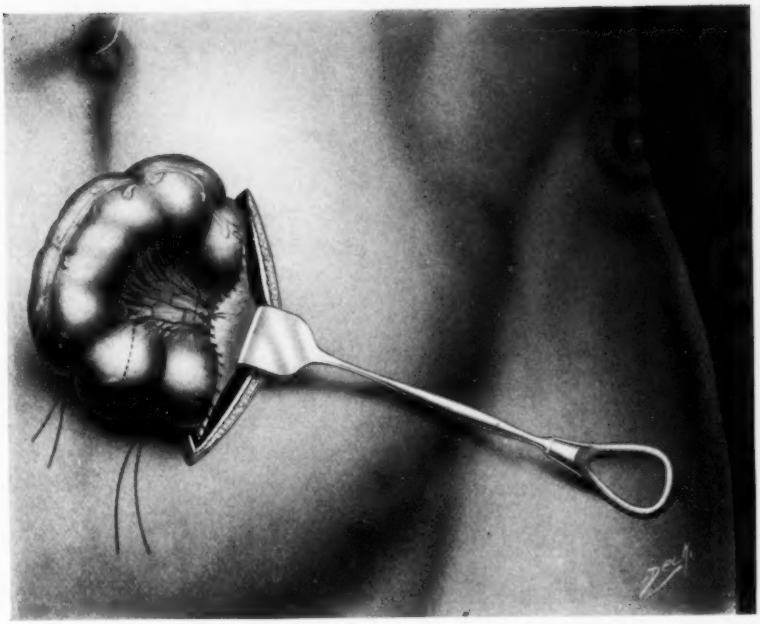
At the lower leg of the loop the gut is doubly ligated very tightly with heavy silk or cotton twine. Section is carefully made between the ligatures, taking care to avoid soiling from the small amount of imprisoned intestinal contents. Pure carbolic acid on a gauze sponge is used to sterilize the mucosa. Chain ligatures of catgut or silk are now passed through the mesosigmoid so as to prevent hemorrhage, and this membrane is then cut across. We now have a short piece of sigmoid, the distal leg of the loop in the lower angle of the wound and a long piece sutured in the upper angle of the wound. The remainder of the mesosigmoid is cut away from the long piece of intestine, freeing it completely. The entire wound is now protected by gauze packings, the peritoneum by our previous procedures being entirely closed off by suture. We should have about 3 or 4 inches of free sigmoid at the upper angle of the wound. If there is more it should be ablated. Four equidistant clamps are now placed at the edge of this upper piece of intestine, the gloved finger is inserted into the lumen of the gut to the place where it is held to the peritoneum by suture; an assistant rotates the clamps so as to twist the gut

around its longitudinal axis, after the manner described by Gersuny, from 180 to 360 degrees according to the texture and thickness of the walls of the sigmoid with which we are working. By withdrawing and reinserting the finger from time to time the degree of constriction which this manœuvre produces may be accurately gauged. When this seems to be sufficient for the purpose—a matter of individual judgment—a few interrupted silk or linen sutures passed through the visceral peritoneum and submucosa to the aponeurosis of the external oblique, hold the rotated gut in position. It is now necessary to make sure by re-examination that a sufficient twist has been accomplished. If this seems satisfactory more sutures should be put in to hold the gut firmly to the aponeurosis.

In examining with the finger now we find a double sphincter, the first one at the twist, the second, more an angulation than a sphincter, at the point of peritoneal fixation. A few chromic gut sutures close the portion of the remaining wound in the aponeurosis. The sphincteric action is maintained by the fibres of the rectus muscle as well as by the twist in the intestine. A large sized, rather stiff-walled rubber rectal tube, not a woven one, is now inserted about 6 inches into the intestine and is tied in place, a single light suture passing through its walls guarding against its accidental extrusion. The remainder of the wound is left open and packed with gauze while the tube is led off into a receptacle at the side of the bed. These wounds always become more or less infected, but I have encountered a true phlegmon only once and then a single incision sufficed for its drainage.

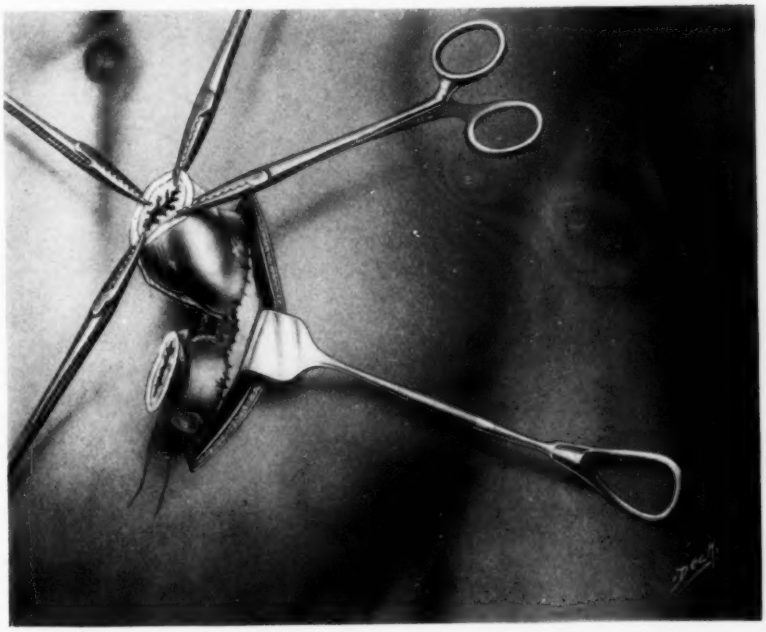
About a week after the operation the tube may be withdrawn and the redundant sigmoid burned off with the actual cautery. Anæsthesia is not necessary. Even then it will be found that repeated cauterizations will be required during the course of the healing in order to bring the intestinal mucosa to the skin level. Daily irrigations through the tube should be practiced so as to keep the patient's bowels open. The string around the lower piece of intestine should be

FIG. 1.



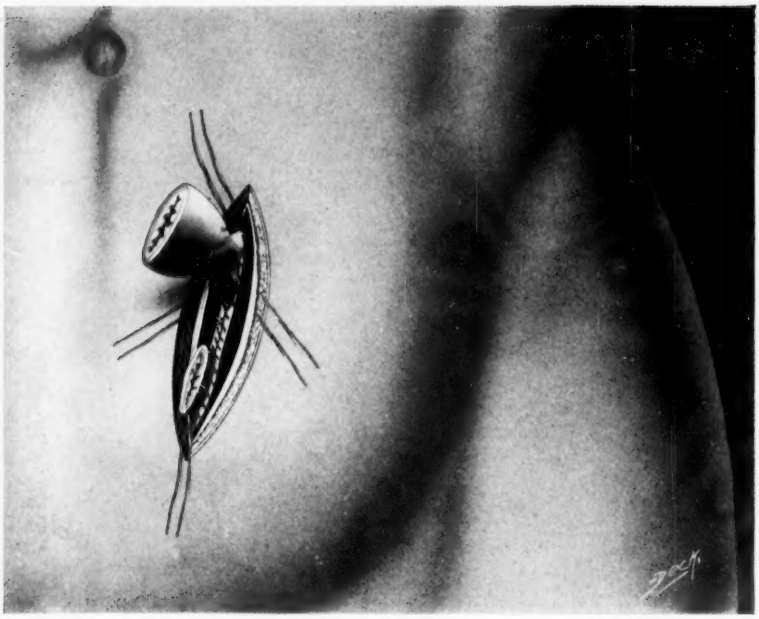
The dotted line shows line of section. The blunt retractor holds outer third of rectus muscle together with skin and aponeurosis.

FIG. 2.



Redundant bowel and mesocolon cut away. Twisting of the intestine begun.

FIG. 3.



Twist complete and maintained in position by anchor sutures holding sigmoid to aponeurosis.

FIG. 4.

Operation complete. Aponeurosis further stitched to intestine and wound closed with the exception of the skin.

removed in three or four days, otherwise there might be danger of complete and permanent closure and it is necessary to maintain patency here for the sake of drainage.

The control of the bowels is learned gradually by the patient, and he is assisted by a constipating diet and, for the first few weeks, small doses of deodorized tincture of opium and of subgallate of bismuth, 20 grains 3 to 5 times a day. It takes about a month for the final result to be attained, but the functional result in all uncomplicated cases will be found perfect.

MYELOMA OF THE LONG BONES.*

BY FRANK S. MATHEWS, M.D.,

OF NEW YORK.

UNTIL recently a list of the benign tumors of the body would have shown one derived from each of its tissues except marrow. Some writers now include "myeloma" in the list, but its significance is variable. This is not remarkable when we remember that this form of tumor is just being differentiated from the sarcomata and that the marrow itself is a complex structure. However, its cells may be divided into two categories: First, those concerned with osteogenesis, such as reticular stroma cells, some of which become fat cells and giant cells known as osteoclasts. Second, the cells lying in the meshes of the former and engaged in blood manufacture, such as myeloblasts, lymphocytes, erythrocytes, and others.

According to Adami, "not only may there be overgrowth of one or other of these orders, but even overgrowth of one particular form." Hence we need not be surprised in the future to learn of several varieties of bone-marrow tumors.

Before recounting the cases forming the basis of this paper, we may remark that none of them belong to the group of tumors to which the term "myeloma" is most often applied. The myeloma referred to is characterized as follows: It is composed of large round or polyhedral cells; it originates in the marrow of vertebræ, ribs and cranium, is a tumor of advanced life, is always multiple and Bence-Jones albumose is found in the urine. X-ray evidence will show that there are multiple tumors, and the detection of albumose in the urine clinches the diagnosis. Adami says this tumor has been recognized for many years under a variety of names. It is uncommon and never forms metastases.

During the writer's connection with St. Mary's Hospital for Children, he has seen clinically or has examined in the

* Read before the New York Surgical Society, April 12, 1910.

laboratory of the hospital five cases of tumor of the long bones, the pathological and clinical details of which follow.

CASE I.—Female, age 40 (patient of Dr. Charles T. Poore, who disarticulated at the knee joint for a central tumor of the upper end of the tibia). Fig. 1 is a recently made skiagram of the bone. The specimen had been split in its long axis. The tumor has originated at the end of the diaphysis, has destroyed bone and exhibited a marked pulsation over the inner tuberosity. The patient has remained well 19 years.

CASE II.—Female, age 28, patient of Dr. Charles N. Dowd, who disarticulated at the knee joint for central tumor of the upper end of the tibia. Fig. 2 is a microphotograph of the tumor which had practically destroyed the upper end of the bone. She was well when last heard from, four years after operation.

In both of these cases the tumor had expanded the bone and had reached such size as to be in contact with periosteum and joint cartilage, though in neither case had these structures been transgressed. Both cases are well, though the point of amputation was no great distance from the disease.

These two tumors in their histology are very similar; they are what is usually called giant-celled medullary sarcoma. The microscopic picture of one of these tumors is very striking. First there is the very cellular spindle-celled stroma; second, a very free vascular supply; and third, the giant cells. They are not called "giant celled" because of an occasional giant cell, as might be the case in a great variety of tumors, but because in these tumors giant cells are of such size and number as to constitute their most conspicuous feature. One may often count a hundred in a microscopic field and one giant cell may have a hundred clearly defined nuclei.

Normal bone marrow contains giant cells known as osteoclasts, some of which have a large, single lobulated nucleus, others many separate nuclei, still others a nucleus like a hollow sphere with holes in it. The osteoclasts, beside being normally found in the marrow, are found under pathological conditions following the course of vessels through the Haversian canals and appearing under the periosteum, where they may be conspicuous in such tumors as the giant-celled epulis of maxilla and mandible.

It is rather attractive to think of the giant cells of a myeloma as

inheriting their characters, though less diversified, from the osteoclasts of bone. On the other hand we may think of the osteoclasts, giant cells of myeloma and epulis, as nothing more than foreign-body giant cells developed in marrow, tumor or periosteum from the adventitia of blood-vessels whenever needed for the removal of foreign particles. Against this may be urged that they are very abundant in the myelomas and rather conspicuously absent in the sarcomas of bone or other tissues.

How shall we classify these tumors? Ribbert,[2] who recognizes but one variety of myeloma (the kind previously described), calls them sarcomata, but says of them: "Barring the local destructive process, the giant-celled sarcomata belong to the less malignant tumors. They grow slowly, are usually extirpated from the bone with good result, even occasionally recede and have little tendency to metastasis."

Sutton calls them myelomata and says they neither infect lymph-nodes nor disseminate.

Adami in his chapter on Sarcoma has omitted giant-celled sarcoma and in a foot-note states that this tumor has been taken from the sarcoma group. It finds a place in the chapter on Myeloma, and of it he says: "It grows locally most often in the shaft (marrow) of long bones or in the jaw; it may also be periosteal, as in the giant-celled epulis of the jaw; its growth is expansile, leading to the absorption of the surrounding bone; it does not form metastases, save in the infrequent cases in which it undergoes sarcomatous modification; it does not recur on complete removal, and, as recently shown, it is only necessary to remove the portion immediately involved with a very small surrounding zone."

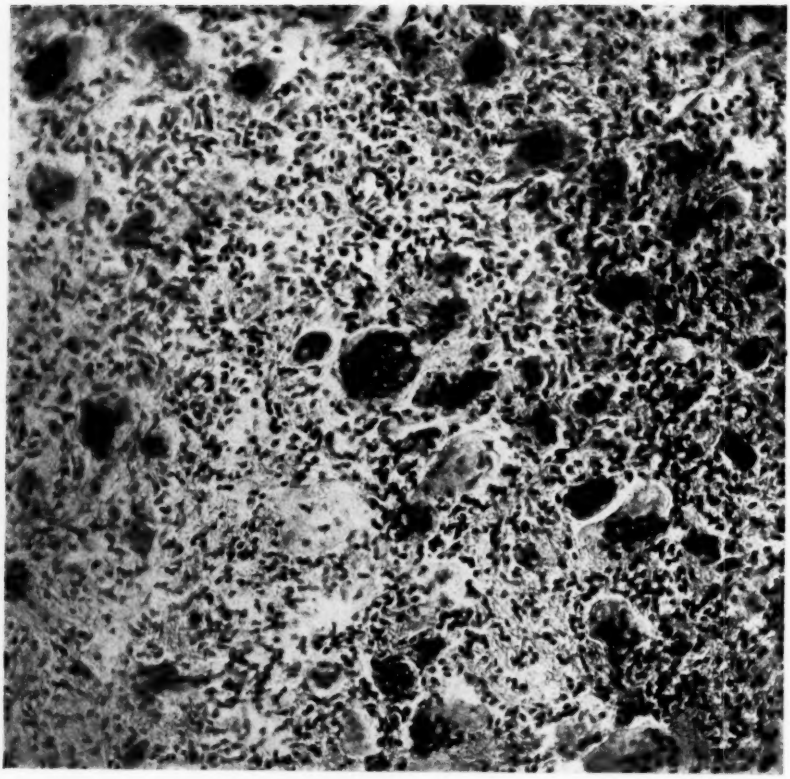
Case III.—H. McG., age 13. Admitted to St. Mary's Hospital for Children, August 27, 1903; discharged October 7, 1903. The boy had had tenderness about the middle of the shaft of the tibia for two months but there had been no severe pain. There had been no inflammation or trauma. In the middle of the tibial shaft there was a fusiform swelling four inches in length. Close to the anterior border of the bone one could feel through the skin covering the inner surface of the shaft a hole about the size of a lead-pencil. A small bluish area resembling a hæmatoma had formed about the spot where the bone had perforated.

Operation.—Under ether the writer made a four-inch incision

FIG. 1.

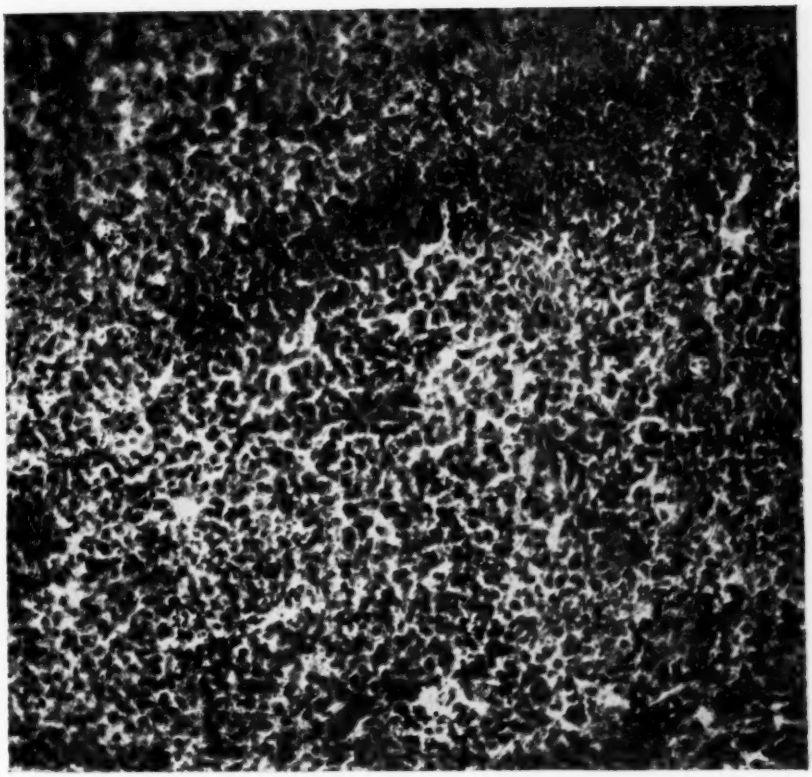
Case I. Myeloma of upper end of diaphysis of tibia.

FIG. 2.



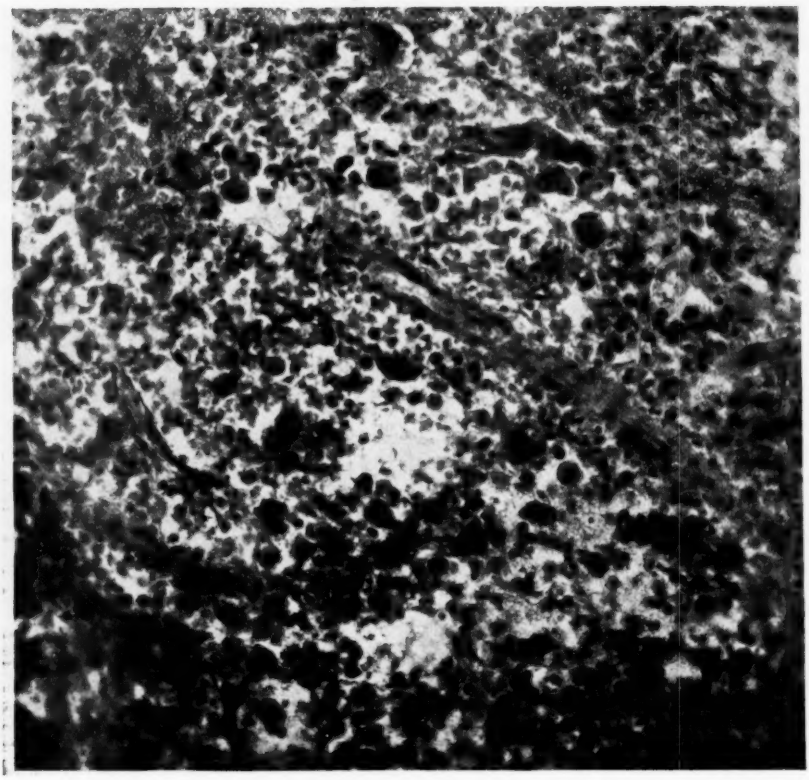
Case II. Typical giant- and spindle-celled myeloma.

FIG. 3.



Case III. Round- and polyhedral-celled myeloma.

FIG. 4.



Case III. Small area showing perivascular giant cells.

FIG. 5.

Case IV. Myeloma of femur.

FIG. 6.

Case V. Osteosarcoma of upper end of tibia.

down through the periosteum which was peeled back and the perforation enlarged until the medullary cavity was opened for about four inches. The medulla was replaced by a red vascular tissue which had perforated the cortical bone at one point. The tumor tissue was removed with a curette. The edges of the gutter thus formed were cut down so that the periosteum could be folded over into the cavity of the shaft as in the Neuber operation. The skin wound was closed and recovery was uneventful. No recurrence has appeared in seven years.

Histology.—The tumor, as might be inferred from its method of removal, is in small pieces and in many areas infiltrated with blood. The tissue is channelled by many thin-walled blood-vessels, and occupying the intermediate spaces is the tumor mass proper made up of large polyhedral cells with fair sized deeply staining nuclei and abundant cytoplasm (Fig. 3). In places the cells contain a reddish brown pigment, probably blood pigment. There are also giant cells, but none of large size. In large areas of the tumor they are entirely absent. In spots they show a tendency to group themselves about blood-vessels or tissue spaces, as illustrated in Fig. 4.

Here we have a tumor rather different in its histology from the two former and one's impression would be that it was more likely to prove malignant. Such, however, cannot be the case, since the tumor had already perforated the bone, since the operation was only a curetting and the growth has not recurred in seven years. I believe the histological and clinical discrepancy to be only apparent. The tumors of the giant-celled variety previously described probably originate in the osteogenetic elements of marrow, and were a tumor of such origin of a distinctly round-celled type it would probably be malignant. But in this case the tumor probably owes its origin to the marrow cells (myelocytes) which are in their normal adult form round cells.

We are not dealing with cells which have widely departed from the normal, hence malignant, but to quote Adami once more, "with cells which when at their fullest development are of relatively simple type."

CASE IV.—P. S., girl, age 5 years. Operated on at St. Mary's Hospital June, 1904, for knock-knees, by supracondylar osteotomy of the femora. Readmitted to hospital May 17, 1909,—age 10

years,—suffering from a tumor of the lower end of femur in the shaft proximal to the epiphysis, as is shown by X-ray.

The story was that a lump had appeared within a few months of the knock-knee operation and had grown steadily. A skiagram was taken and amputation recommended but refused. This tumor then by X-ray (Fig. 5) shows the characters of the giant-celled myeloma; it had existed nearly five years, had not impaired the patient's general health and had apparently not formed metastases.

The writer saw this patient again on March 7, 1910, nearly six years after the knock-knee operation. In the past nine months the tumor has increased considerably in size. The patient puts very little weight upon the limb. Bone has disappeared in spots and in others there are thin plates. The circumference of the thigh is 18 inches. The child is undersized but not ill-nourished, and abdominal and chest examination is negative. She gets about by using a crutch. Pathological fracture has not occurred.

CASE V.—A. D., age 14. Admitted October 6, 1902. This child also had a growth at the upper end of the tibia. Amputation was done by Dr. Dowd above the middle of the thigh. She was removed from the hospital on January 28, 1903, with the wound unhealed, the disease progressing in the stump and presumably disseminating, as she left the hospital in very poor condition. This case contrasts in many ways with those above mentioned. The disease was given a wider berth at operation, but three months later was progressing to a fatal termination.

This growth would be classed as a spindle-celled periosteal sarcoma. Reference to the skiagram of the bone, Fig. 6, shows that the growth was actively engaged in bone formation, an osteosarcoma as distinguished from the myelomas which are destructive of bone. Sections from parts of the hard tumor showed all of the different stages seen in the development of normal bone in cartilage. There can be seen hyaline cartilage, absorption of the cartilaginous matrix, calcified cartilage and fairly typical new bone. As soon, though, as one leaves the original growth attached to the tibia and examines detached tumor masses—say in the skin—one finds

none of the tissues mentioned, but only a typical large spindle-celled sarcoma.*

The papers of Nancrède [8] and Coley,[4] which have appeared within a year, warn us of the terrible malignancy of bone sarcoma. Sutton tells us of a case of his that ran its course within three months, the patient being suffocated by intra-thoracic calcified metastases. As these very malignant tumors of the periosteum often invade the bone and marrow, it is not unlikely that at times they have been mistaken for medullary growths and hence a malignancy attributed to medullary tumors, which they do not deserve. Rotch [6] shows a very good skiagram of a periosteal sarcoma invading the bone.

The myeloma here considered then is a tumor resembling the red marrow of young bone characterized by great vascularity, by giant cells and spindle to round or polyhedral cell structure. It is benign. Nearly all writers agree that it does not form metastases. It is admitted that it might undergo a sarcomatous transformation just as a myoma of the uterus might. Bloodgood, who calls them sarcomata, says he has investigated 100 such cases without having found one authentic case of dissemination.

We may say that it possesses a malignancy of the second order,—that is, from its local destructiveness,—hence leading to the sacrifice of limbs. Clinically it selects most often the upper end of the tibia, less frequently the lower end of the radius. Then comes the femur, mandible, humerus, ulna, and clavicle in a series of diminishing frequency.

The patients are usually under twenty-five years of age. There was a history of trauma in but one of our cases. The growths are described as "expansile," which means that bone is destroyed by the tumor, while new bone is being deposited by the periosteum. When the tumor reaches the periosteum

* It has been maintained by some that in cases like this the sarcoma does not form specialized tissues like cartilage and bone; that the sarcoma is destructive only, and that its presence stimulates normal cells of the periosteum to form these tissues, *i.e.*, that the sarcoma cells and bone-forming cells are different, simply intimately associated in the mixed growth. In this tumor one can see almost every gradation from spindle-celled sarcoma to normal bone.

we find thin scales of bone being formed which give the egg-shell crackling. The vascularity of the tumor and the disappearance of bone give rise finally to a pulsatile growth and the impression of "bone aneurism." While a myeloma destroys bone, spicules of bone often penetrate the tumor from the surface after the manner of the new bone in subperiosteal hæmatoma. This may delay spontaneous fracture.

A number of writers say these tumors may occasionally retrogress. One case described by Coley [7] would seem to be of this kind. Two inches of the lower end of the radius had been resected by Hibbs. Two years later the cavity was occupied by a soft mass of tissue and the wound had refused to heal. Bull, Curtis and Coley recommended amputation, which was refused, and the patient recovered without other treatment and was well six years from the date of resection of the radius.

Diagnosis.—In the early days of such growths the X-ray picture will aid greatly. These growths usually originate in the diaphysis of the long bones adjacent to the epiphysis. This is well shown in Fig. 5 and less well in Fig. 1. Rotch [6] shows a skiagram well illustrating this origin. Even when the disease is advanced and the epiphysis involved they do not perforate the joint cartilage. They may stretch the periosteum without invading or destroying it for years, as in Case IV. If we diagnose a tumor of marrow by X-ray or otherwise, we are fairly safe in assuming it to be a myeloma. Sutton says, "I am inclined to think that round- or spindle-celled central sarcomata of the tibia are rare tumors."

Assuming then that we are dealing with a myeloma, it may be the multiple myeloma already mentioned. This will probably occur in the aged, and skiagrams of a number of bones will show multiple tumors. Those chiefly affected are the cranial bones, vertebræ, sternum and ribs. Albumose is found in the urine. On the other hand, the giant-celled variety will affect the extremities and mandible—most often the tibia. The patient will be young and the tumor single.

Treatment.—The writer has been interested in reading for the last ten years Bloodgood's articles on bone tumors in

Progressive Medicine. Much credit is due to him for urging the conservative treatment of the myelomas. He calls them giant-celled sarcomas, but says he has never heard of one disseminating, that he has personal records of 16 cases of such tumors of the long bones and that all are alive and well. This is indeed very unlike the behavior of sarcoma, certainly of bone sarcoma. So long, however, as these tumors retain the name sarcoma we may expect the average surgeon to accord them the usual treatment of sarcoma, namely: the widest possible removal. Since nothing worse than a local recurrence is to be feared after operation on the myelomas, and since medullary round- or spindle-celled sarcoma is so exceedingly rare, we are justified in palliative operation and even exploratory incisions and final resort to microscopic diagnosis.

If the diagnosis of myeloma is reasonably sure we may curette the disease in cases where a bone shell can be left behind. In other cases a subperiosteal resection may be employed. In the lower end of the radius this procedure has the advantage over the ordinary resection, that the ulna does not have to be resected too, as would be the case when the periosteum of the radius is sacrificed. In the case of the upper end of the tibia, amputation has been the rule, but some cases have been curetted, leaving a large cavity which has required a year or two for healing and filling with new bone.

Tumors in which the periosteum has been reached and stretched out by the growth may still be curetted, with the possibility that repeated curettings may finally bring a cure, as has been the result in some cases, or the attempts to preserve the limb may fail and amputation be finally required. Sutton speaks as though amputation were necessary when the femur is involved; but though without experience in such cases, I see no reason why in an early tumor where the epiphysis is uninvolved a resection of part of the bone or a subperiosteal resection should not be tried in the former case, expecting a short limb. Our Case IV would seem too extensive for such treatment, and conservatism would seem only to suggest the preservation of a stump of the femur to permit of

the use of an artificial limb. It is to be remembered that some cases have retrogressed after an operation which was deemed incomplete.

The skiagrams presented were made by Dr. Louis Gregory Cole, the microphotographs by Dr. Edward Leaming. I am indebted to Drs. Poore and Dowd for the privilege of using their cases.

REFERENCES.

[1] Adami and Nicholls: Principles of Pathology, 1909.
[2] Ribbert: Geschwultzlehre, 1904.
[3] Sutton: Tumors Innocent and Malignant, 1906.
[4] Coley: Plea for More Conservative Treatment of Sarcoma of Long Bones, Jour. A. M. A., Jan. 29, 1910.
[5] Bloodgood: Progress. Medicine, Dec., 1907, and Dec., 1909.
[6] Rotch: Röntgen Rays in Pediatrics, 1910.
[7] Coley: Sarcoma of the Long Bones, ANNALS OF SURGERY, March, 1907.
[8] De Nancrède: End Results After Total Excision of the Scapula for Sarcoma, ANNALS OF SURGERY, July, 1909.
[9] Trotter: Diagnosis of Common Swellings of the Long Bones, The Clinical Journal, London, 1907.

ADDENDUM.—After the above had been put in type the writer discovered the very thoughtful paper of Wilfred Trotter and inserts a few quotations from it bearing on our topic.

"The myeloid tumor is by far the most common and produces a characteristic and stable clinical type. As is well-known, all varieties of sarcoma of bone are apt to contain giant cells. Except in the myeloid these cells are relatively small, do not contain more than three or four nuclei and occur in small numbers. In microscopic diagnosis of a myeloid it is necessary therefore to establish that the tumor contains large numbers (several in a low power field) of giant cells of a special type. These, the true myeloid cells, are very large and contain a dozen or more of nuclei massed in the centre of the cell. Unless such a definition of a myeloid sarcoma be accepted, avoidable errors in prognosis are likely to be made."

* * * "It causes a globular enlargement of the ends of bones and the enlargement ceases abruptly with the limits of the tumor. Spontaneous fracture is rare except in late cases. The articular cartilages and to a less extent the epiphyseal cartilages show a marked resistance to the advance of the tumor so that the actual epiphysis may escape expansion."

* * * "If a swelling which by its firmness and well-defined outline suggests a tumor and by its involving the whole circumference, a central tumor, shows a bossy surface and an absence of globular limitation but rather a tendency to spread far along the shaft then it is not a myeloid but a central sarcoma of other structure."

As to periosteal sarcoma—"A section of a specimen will generally show that the growth has quite early penetrated the bone and extended along the medullary cavity. There is a greater tendency to fracture than with myeloid sarcomata."

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY.

Stated Meeting, March 23, 1910.

The President, Dr. Ellsworth Eliot, Jr., in the Chair.

OSTEOSARCOMA OF THE LOWER JAW TREATED BY PARTIAL OPERATION FOLLOWED BY MIXED TOXINS (Erysipelas and Bacillus Prodigiosus).

Dr. William B. Coley presented a boy, seventeen years old, whose family history was good, and who gave no history of antecedent injury. When admitted to the General Memorial Hospital, January 10, 1910, he stated that he had always been in good health until the latter part of November, 1909, when he noticed an enlargement of his lower jaw, most marked in the region of the symphysis. The tumor grew very rapidly, extending on both sides, and soon involved the floor of the mouth. There was no pain at any time.

Examination showed a tumor, 4½ by 2½ inches in size, smooth and symmetrical, occupying the entire lower portion of the jaw and extending back nearly to the angle on either side. There was also a mass projecting downwards fully an inch beyond the normal outline of the bone. The mass in the floor of the mouth was continuous with the jaw, and filled up the space nearly to the level of the teeth. The skin over the chin was normal, and there was no evidence of ulceration in any part of the tumor. In consistence, the growth was very firm and hard, a typical osteosarcoma, causing marked deformity due to the elongation of the chin.

Inasmuch as the only operation that could be performed with any hope of success would have been removal of almost the entire lower jaw as far back as the angle, it seemed wiser to do a partial operation, to be immediately followed by the use of the mixed toxins. Therefore, on January 11, 1910, with the assis-

tance of Dr. William A. Downes, the following operation was done: The lower lip was drawn forcibly downwards, without cutting it. The mucous membrane on the inner side was then cut, exposing the outer portion of the tumor. The soft parts were separated from the tumor, and by means of a chisel the larger part of the external portion of the tumor was removed, a sufficient amount of alveolar process being left to hold the teeth firmly. The inner portion of the tumor, which was somewhat larger in size than an English walnut, and occupied the floor of the mouth, was not touched at all. Macroscopically, the tissues removed were typical of osteosarcoma.

A microscopical examination of the tissues was made by Dr. James Ewing, who reported it as a giant-celled osteosarcoma. It was not the ordinary encapsulated giant-celled sarcoma of the jaw or of the epulis type, but a tumor infiltrating in all directions, of rapid growth and with a large amount of new bone formation.

Two days after the operation the patient was put upon small doses of the mixed toxins, given in the pectoral region. These injections were continued about four times a week during his five weeks' stay in the hospital, 28 injections in all being given. Only three of these were made into the tumor on the floor of the mouth.

After the boy's return to his home in Poughkeepsie, where he was under the care of Drs. Sadler and Borst, the injections were continued three times a week, the highest dose being five minims. They produced a moderate reaction, with an occasional chill followed by a temperature of 103 or 104, but usually only by slight malaise and a temperature of 99 or 100.

After the first three or four injections there was noticed a marked diminution in the size of the growth that had been left behind, both externally and internally, and when he left the hospital, the tumor in the floor of the mouth had diminished to one-third of its original size. Since then, the remainder of the tumor had nearly disappeared. The tumor tissue which was necessarily left behind externally had also gradually become absorbed, and there was absolutely no deformity remaining.

FIBROSARCOMA OF THE UPPER JAW.

DR. COLEY presented a man, twenty-five years old, whose family history was good, and who gave no history of trauma. Three months before the patient first noticed a swelling of the upper

jaw, left side. This tumor gradually increased in size, causing partial obstruction of the left nostril.

Operation, February —, 1910, Dr. Downes assisting. An incision was made through the mucous membrane just over the alveolar process, and through an opening into the antrum about the size of a small English walnut the tumor was removed by gouge and curette. The tumor was not encapsulated; the cells were moderately infiltrated.

Dr. Coley said that in view of his success with the previous case of osteosarcoma of the lower jaw, it seemed advisable to try the mixed toxins in this case also before resorting to such an extensive operation as complete removal of the upper jaw. Accordingly, four days after the operation, the patient was put upon the toxins, which were repeated four or five times a week. All of the injections were systemic, being given in the pectoral region. At the end of about two weeks, the remaining portion of the swelling had gradually subsided, and although it was still apparent, it was steadily decreasing in size. Should there be any evidence of an increase, an immediate radical operation would be done.

SARCOMA OF THE OMENTUM.

Dr. Ellsworth Eliot, Jr., presented a woman forty-six years old, who was admitted to the Presbyterian Hospital in November, 1908, with a large uterine fibroid for which a supravaginal hysterectomy was done, removing the tumor, together with the left tube and ovary and the right tube. The pathological report was "fibroma of the uterus." There were several large tumors, one of which showed central degeneration. The patient left the hospital cured.

She was re-admitted in July, 1909, complaining of a feeling of abdominal distention and weight, with increasing distress. There was loss of appetite; the bowels were regular; no vomiting. Examination disclosed the presence of an intra-abdominal mass.

Operation, by Dr. George Woolsey.—Upon opening the abdomen a considerable amount of blood-tinged, non-odorous fluid escaped, and a tumor about the size of a large grape fruit came into view. It was smooth and shiny, and purplish red in color. It was freely movable, and attached broadly to about six inches of mesentery and ten or twelve inches of small intestine, with several other loops adherent. It was also attached to the omen-

tum by two pedicles. The adherent intestine was easily separated from the tumor, which was soft, elastic, friable and non-fluctuating. The mesentery was more firmly adherent, but after incision the peritoneum could be stripped off with gauze, each bared place bleeding profusely. The pathologist reported that the growth was an encapsulated tumor composed of spindle cells with large nucleus-like cells of fibrous tissue; mitotic figures; rapid growth. Diagnosis, fibroma, much resembling spindle-celled sarcoma.

The patient again presented herself on February 28, 1910. She stated that in the latter part of November, 1909, while examining her abdomen, she found a tumor the size of a fist. She had had no other symptoms. The bowels were regular; no flatulence; no vomiting. Her weight had increased since her previous stay in the hospital. Examination showed a prominence of the abdomen on the right side and below the navel, where a mass was felt which extended from the level of the navel to the pelvic brim. It was firm and hard and freely movable, excepting that it seemed to be bound down posteriorly. It was rough to the feel, was not tender and no softened areas could be made out.

Operation, by Dr. Eliot.—On opening the abdomen a globular mass, about six inches in diameter, was exposed. Its surface was irregular, and showed large veins. It was adherent to loops of small intestine, to the ascending and transverse colon and to the omentum and mesentery, and contained a small amount of serosanguinous fluid. After separating the adhesions, the tumor was removed. The pathologist reported that it was a spindle-celled sarcoma.

Dr. Eliot said that while he understood that malignant degeneration of a fibroid tumor was not an infrequent or rare secondary condition, still this was the only instance that he could recall among the considerable number of fibroid tumors that had been seen and operated on at the Presbyterian Hospital during the past ten or fifteen years.

Dr. George Woolsey said that the tumor removed by him from the patient shown by Dr. Eliot at that time had all the appearances of a malignant growth. What it grew from was a question, but it appeared to grow from the mesentery. It had some resemblance to a mesenteric cyst, but was more solid to the

feel. It was more adherent to the mesentery than to any other structure and the adhesions were very vascular.

A short time after operating on this case, Dr. Woolsey said, he had another case of a very rapidly growing tumor of a similar kind, but much larger and more vascular. It was three or four times as large as the one in the first case. In this second case the growth was a sarcoma. The patient died from shock.

Dr. Coley, discussing Dr. Eliot's case, said the change in the type of a tumor from fibroma to sarcoma was well illustrated in a case reported by the late Dr. A. J. McCosh, where a Princeton student, following an injury, developed a tumor which was pronounced a pure fibroma. It was removed, but recurred within a year, and at the second operation it was pronounced a fibroma with some spindle-celled sarcomatous elements. It recurred again, and then showed distinct type of spindle-cell sarcoma. At a still later recurrence it proved to be highly vascular, and at the time of the patient's death, instead of a spindle-celled sarcoma, it was almost of the pure round-celled variety.

Dr. Coley said he could recall two or three other cases where a similar malignant degeneration had taken place, and this emphasized the importance of giving heed to the clinical signs of malignancy even if not confirmed by the microscopical examination. In the case shown by Dr. Eliot, some of the infective cells were doubtless left behind, and a further recurrence was almost certain to occur. For that reason, it might be advisable to employ the mixed toxins as a prophylactic measure.

Dr. Frank S. Mathews said that the number of uterine fibroids that underwent sarcomatous transformation was probably very small. Of 1700 such cases observed by Cullen, only one per cent. showed sarcomatous changes. In a myoma œdema and various degenerative changes may simulate sarcoma. Most of the sarcomas of the uterus begin as sarcoma of the mucosa; occasionally one originates in the musculature independent of any myoma.

Dr. Robert T. Morris said that in one case where he had removed a fibromyomatous uterus and left the cervix two years ago, a large tumor had recently developed rapidly from the cervix. He had removed this last week. Macroscopically, it was apparently carcinoma, but he had not yet received the pathological report.

VOLVULUS OF THE SMALL INTESTINE IN A CHILD.

DR. WILLIAM A. DOWNES presented a girl, nine years old, who was admitted to the New York Hospital, in the service of Dr. Frank Hartley, on November 21, 1909.

With the exception of measles, the child's past history was negative. Two days before admission she was taken with violent abdominal pain, cramp-like in character, and accompanied by vomiting. The bowels had moved about the time the pain began, but not since. The pain was general at the outset, but later became more marked at the umbilicus. At the time of admission, the child's temperature was 98.4; pulse, 160; respirations, 24. She was in a condition of extreme shock, with ashen color and cold extremities. The abdomen was retracted and fairly rigid, this being most marked in the umbilical region. A rectal examination showed an indefinite mass at about the level of the brim of the pelvis. No bloody mucus was passed. No blood count was made, as the child was taken immediately to the operating room.

Operation.—The abdomen was opened through an intermuscular incision, and upon incising the peritoneum, about a pint of bloody serum escaped. The appendix presented, and excepting for a small concretion, it was normal and was not removed. Upon passing the finger along the ileum, about a foot from the ileocæcal junction, the gut became deeply congested. The incision was then enlarged by splitting the sheath of the rectus, and fully one-half of the small intestine was found to be mahogany colored, with soggy walls. No definite twist of the mesentery could be made out. The vessels seemed palpable, but as no pulsation could be made out the condition was thought to be a mesenteric thrombosis. The peritoneum had not lost its lustre, nor did it break at any point during manipulation, but after waiting for ten minutes and wrapping it in salt compresses, the color did not improve.

The extent of the involvement and the general condition of the child, even though the vitality of the gut seemed extremely doubtful, made any attempt at excision out of the question. It was therefore decided to leave the entire mass outside of the abdominal cavity. Gutta-percha tissue was wrapped around the coils, and this was covered with gauze wet with salt solution. An infusion

of salt solution was given during the operation. At the completion of the operation, vomiting ceased almost immediately.

At the end of 24 hours the gauze dressing covering the intestines was changed. At this time, the color of the gut, seen through the gutta-percha dressing, was almost normal. At the end of 48 hours the dressing was done under ether, and the intestine was found to be absolutely viable. The mesenteric arteries were pulsating, and no trace of the former condition was visible. The fibrin was removed from the coils of intestine, which were then returned to the abdominal cavity, and the wound was closed with the exception of a small opening for drainage. The child's recovery was uneventful.

Dr. Coley said that in one case where he had removed four feet of the small intestine for a strangulation of the gut, the patient made a good recovery, but subsequently suffered from a very severe diarrhœa lasting a year. This condition was especially annoying after taking meat or solid food, while on a rice diet he got along fairly well.

Dr. Downes said that in one case where he removed three feet of the small intestine, the stools were not affected.

INJECTION OF BLOOD FOR AN OLD UNUNITED FRACTURE OF THE TIBIA AND FIBULA; RESULT, BONY UNION.

Dr. Henry H. M. Lyle presented a man, forty-six years old, who sustained a compound fracture of both tibiæ and fibulæ. He was taken to a hospital where he was operated on September 30, 1908. The fragments were reduced, the ends of the bones trimmed and the splinters removed. Three and a half months later there were no signs of union. A second operation was done at which sections of the bones were removed and the ends freshened. This was also unsuccessful, and four months later there were no evidences of union. At a third operation an attempt was made to correct the position of the bones and freshen the ends. Orthopædic braces were applied, and the ends of the bones stimulated under gas. This also proved unsuccessful.

A year after the original operation the patient was admitted to St. Luke's Hospital, in the service of Dr. Charles L. Gibson. Examination showed an ununited fracture of the right tibia and fibula, and weak fibrous union between fragments of the left tibia and fibula. Operative and orthopædic measures having

failed, it was decided to try Bier's method of blood injection combined with passive hyperæmia. Accordingly, twenty c.c. of the patient's own blood was injected between the fragments. Four injections were given, and at the end of three weeks there was firm fibrous union. Three weeks later there was bony union and the leg was so strong that the patient could bear his weight upon it.

CHOLELITHIASIS, SIMULATING CARCINOMA.

Dr. Eliot presented a man, sixty-five years old, who was admitted to the Presbyterian Hospital on February 16, 1910. He had always enjoyed good health until about two months before admission, when he was exposed in a cold room for several hours. This was followed by a chill and an attack of vomiting. For two weeks he complained of constant chilliness, his appetite became poor and he had hot sweats after going to bed. He gradually lost strength. Two weeks later, after a second exposure, he was obliged to remain in bed three days with a severe cold "all over." Since that time he had complained of chilliness; he had lost 50 pounds in weight and much strength. He had a dull, continuous frontal headache and suffered from occasional sweats, usually at night. He thought he had become very pale.

Six weeks prior to the patient's admission he began to have attacks of vomiting, usually occurring about half an hour after eating, especially if he partook of meat. There was no nausea between the attacks of vomiting and no eructations of gas. The quantity of the vomitus was always small, and apparently consisted only of food particles. He was constipated. The stools were of the usual color, but small in amount.

Physical Examination.—The patient was moderately emaciated, with loose skin of a slight icteroid hue. The mucous membranes were somewhat pale. The patient looked cachectic. The breath was sour; the tongue heavily furred. The edge of the liver was an inch and three-quarters below the costal margin in the right midclavicular line; it could not be felt below the costal margin in the axillary line. It was thin and smooth, and felt as though it were being pushed forward from behind. On the edge, about two inches from the mid-line, there was an indefinite sense of resistance. There was no tenderness.

The urine showed no significant changes and contained no

bile before the operation. A gastric analysis gave a total acidity of .197 per cent.; free hydrochloric acid, .058 per cent., and a trace of lactic acid.

Operation.—This was exploratory in character. A median incision was made above the umbilicus, through which the stomach, gall-bladder and ducts, the duodenum, the pancreas, etc., were explored. As the gall-bladder was found to be enlarged, a second incision was made so that better access might be gained. Upon opening the gall-bladder, a stone, about the size of a large olive and very soft in consistence was found in the neck. The bile was turbid and brown. There were adhesions about the cystic duct and pylorus. No new growth was found. The calculus was removed, and a catheter sewed into the gall-bladder for drainage.

The patient made a good recovery from the operation. About twelve or fourteen ounces of bile, which soon became green and clear, drained into a bottle for the first few days, and on the fourth day the catheter was replaced by a rubber tissue drain. Since then the bile had flowed almost continuously from the wound, which had nearly healed. Since the operation, the patient had become brighter and had apparently gained some weight. The urine had persistently shown bile, and the stools were still clay colored, having been so since the operation. The patient was still in the hospital, but was allowed up in a chair and was slowly gaining.

Smears and cultures from the gall-bladder showed various kinds of bacteria, some resembling the colon bacillus.

This case, Dr. Eliot said, was of special interest because it seemed to show a chronic condition of the gall-bladder that in its symptoms resembled carcinoma. The results of the test meal corresponded with carcinoma, as did the condition of the liver itself. The slight jaundice from which the man had suffered had entirely disappeared.

RECURRENT FLOATING CARTILAGE OF THE KNEE-JOINT ("JOINT MOUSE").

Dr. Eliot presented a boy, twenty years old, who was admitted to the Presbyterian Hospital on February 16, 1910. The history he gave was that three years ago, while running rapidly, he turned suddenly at right angles toward the left, using his

right leg to make the turn. He felt a sudden, sharp pain in the right knee joint, and limped home. Since that time he was occasionally seized with a sudden pain in the knee while walking, especially on going down stairs and on marked flexion of the leg. The knee occasionally became swollen. The patient had noticed a movable body in the joint, which he could slip about with his fingers.

He was first admitted to the hospital in December, 1908, and a small, movable, rounded body was made out in the right knee, just external to the patella. An operation was done, and a flattened piece of cartilage, about ¾ by 1 by ¼ inches in size was removed from the joint cavity. He was discharged cured in January, 1909.

The following September, when swimming or walking, he felt a wobbling sensation in the right knee-joint. This gradually became more pronounced. Sometimes, when walking, the right leg would give way suddenly. He could demonstrate a small movable body just to the outer side of and a little above the patella.

Operation, by Dr. Eliot.—A four-inch incision was made over the outer part of the knee. This was deepened through the capsule, the joint cavity was exposed, and a small loose cartilage about the size of a small olive was removed. The joint cavity, which was not touched with the hands, was then irrigated with saline solution, and closed. The wound healed primarily. After three weeks in bed a plaster case was applied and the patient allowed up on crutches. The knee was in perfect condition at the time of his discharge from the hospital, on March 14, 1910.

RELAXATION OF THE INTERNAL LATERAL LIGAMENT OF THE KNEE, WITH EFFUSION INTO THE JOINT.

Dr. Eliot presented a young man, twenty-four years old, who was admitted into the Presbyterian Hospital on January 25, 1910. Shortly before admission he had fallen, twisting his left knee. He was unable to stand, and had a sharp pain in the knee.

Operation.—A curved incision was made over the internal lateral ligament, which was found to be relaxed but not inflamed. There were evidences of effusion into the joint, which was not opened. The relaxed ligament was reefed from above downward with chromic gut, and the wound was dressed and the joint put

up in plaster of Paris. The wound healed with primary union and the effusion rapidly subsided. The patient was discharged cured on January 25, 1910. On March 1 there was no lateral movement of the joint, although the patient still wore a lateral splint.

APPENDICOSTOMY FOR ULCERATIVE COLITIS.

DR. ELIOT presented a man, twenty-six years old, who was admitted to the Presbyterian Hospital on December 1, 1909, with the history of attacks of dysentery extending over the past three years. An examination showed ulcerations of the rectum and colon, and *Amœbæ coli* were found in the stools.

Colonic irrigations with solutions of silver nitrate and creolin were given, but without improving the patient's condition, and as there was progressive loss of flesh and strength, an appendicostomy was done. The appendix was about the size of an ordinary lead pencil, and contained *Amœbæ coli.*

A catheter was introduced into the amputated appendix, and irrigations were commenced the day following the operation, and repeated two or three times daily. For the first three days saline irrigations in large amounts and at a temperature of from 110 to 115° F. were employed. Then a 1–3000 quinine solution was substituted, the irrigation being given once daily. This was followed by an improvement in the character of the fecal discharge, and at the end of a week the quinine irrigation was given every other day. There was a steady improvement in the patient's condition; he gained flesh and strength, the tongue was clean, and the stools nearly normal. The patient had a slight relapse six weeks after the operation. The irrigations were still given once a week. The patient had returned to work.

DR. ROGERS said that in cases of colitis due to the presence of the *Amœbæ coli* the patients could not be pronounced cured until at least two or three years had elapsed. In one of his cases where an appendicostomy was done three years ago the patient had frequently considered himself well, only to find that the colitis promptly returned when the irrigations were suspended. Dr. Rogers said he had always supposed that the amoeba could not grow on the external skin, but in the case he had in mind the patient had an ulceration on the buttocks, and scrapings from this showed the presence of the parasite.

Dr. Eliot said he had one patient upon whom this operation was done at least five years ago, and who was still obliged, at irregular intervals, to repeat the irrigations. Personally, the speaker said, he believed a permanent opening should be left, as these patients were never beyond the danger of a recurrence of the colitis.

TRAUMATIC ASPHYXIA.

Dr. Eliot showed a man, twenty-three years old, who was admitted to the Presbyterian Hospital on November 20, 1909. The history obtained was that while fixing an elevator door, the weights of the elevator fell, striking his left shoulder. These weights amounted to 16,000 pounds, and as they fell the elevator stopped automatically, so that he was subjected to the weights for a fraction of a second only. At the time of the accident, he wore a soft shirt and collar.

When observed, the patient's face was black, with a sharp line of demarcation running around the neck, separating this darkened area from the normal flesh. He was conscious but dyspnœic, and unable to see with the right eye; the left eye was normal. There were ecchymoses over the thorax, especially over the upper left half. The face was deeply cyanosed (Fig. 1); there were râles in the chest. Pulse, 90; temperature, 99.5; respirations, 24. The pain following the accident was so severe as to require morphine. The patient complained of severe headache for five or six days; after that it became less intense. There was exophthalmos of the right eye, with sub-conjunctival ecchymoses in both. The optic nerve of the right eye was very pale, and showed signs of beginning atrophy.

The patient left the hospital on December 5, 1909, improved. Four weeks after the accident his condition was apparently normal, excepting for complete blindness in the right eye. Dr. Eliot said the unilateral character of the eye symptoms in this case seemed to be due to the fact that the blood could be more easily forced through the right innominate vein than through the left, and that the blindness was due to the forcible transmission of the blood through the veins.

Dr. Frank J. Parker said that when he had made his first examination of the eyes in this case, which was about two weeks after the patient's admission to the hospital, he found marked extravasation of blood under the conjunctivæ of both eyes, and

FIG. 1.

Dr. Eliot's case of traumatic asphyxia.

slight exophthalmos of the right eye. In the left, which was his good eye, the fields were normal to light, and the rotation of both eyes was normal. The retina was normal, excepting slight dilatation of the veins, and the arteries and nerves were normal. In the left eye, the pupil reacted to light, but very sluggishly. In the right eye the man had no vision whatever—not even perception of light. The optic nerve was atrophied, the condition found being known as "white atrophy." The veins were tremendously engorged and tortuous, and the arteries were very small. Perception of light was never recovered in this eye, the nerve gradually changing to "gray atrophy," which was a permanent atrophic condition.

Dr. Parker said the records showed about twelve cases similar to the one shown by Dr. Eliot, but this one was unique in the presence of complete atrophy of the optic nerve. The lesion was probably an effusion of blood into the optic nerve, close to the disc.

SIMPLE FRACTURE OF VERTEBRA, WITH CONTUSION OF THE CORD.

Dr. Eliot presented a man, thirty-four years old, who was admitted to the Presbyterian Hospital on April 21, 1908. The history obtained was that while trying to board a moving trolley-car he sustained an injury to his spine and was brought to the hospital in an ambulance. There had been no loss of consciousness. After the injury he complained of numbness in the lower extremities and slight pain in the right knee. He could partially flex the right knee, and there was slight movement of the right toes. There was loss of control over the bladder and rectum. No respiratory symptoms.

When the patient was admitted he was in a state of shock. The eyes were normal, with the exception of some ecchymosis under the upper lids and under the left conjunctiva. There was a contusion of the head in the occipital region, but no symptoms referable to the head, ears, throat, tongue, speech, etc., were found. Examination of the spine showed a depression at about the level of the twelfth dorsal vertebra and a corresponding projection of the vertebral spine sharply backward, indicating a dislocation between the fragments of at least three-quarters of an inch in the horizontal plane. This deformity largely disap-

peared when traction was made under an anæsthetic. Above this point there was crepitus and swelling of the soft parts. The abdomen was rigid. The upper extremities were not affected. In the lower extremities there was complete loss of function, with the exception of slight motion of the right toes and partial flexion of the right knee. Sensation in the lower extremities was apparently unimpaired, excepting for slight hyperæsthesia. The reflexes were absent. The penis was erected.

The condition of shock soon passed off, leaving the patient with severe pain in the legs, mostly below the knees. On the day of admission, April 21, 1908, the patient was given ether, while traction was applied to the legs and a plaster case applied to the back. He was then put to bed with extension on the legs and shoulders. The extension apparatus was taken off after 48 hours, for fear of pressure sores. On April 24 he could move the thighs slightly, the right more so than the left. He complained of severe pain in the legs and in the abdomen when the bladder became distended. There was no apparent loss of sensation. On April 27 the motion in the thighs had slightly increased; the reflexes were absent in the lower extremities; both the deep and superficial cremasteric reflexes were present. Temperature, pulse and respiration were normal.

On April 30 the motion in the legs had increased. The pains in the legs had disappeared and there was a sensation of pins and needles in the lower extremities. On May 5 motion in the legs was still further increased, especially in the left. The sense of touch was diminished below the knee, especially on the right side, and over the same area there was a loss of sensation to heat and cold. The reflexes were still absent. On May 15, when the plaster case was removed, an examination of the spine showed no deformity. On the following day the patient voided urine normally for the first time. The bowels were still emptied by enemata. On May 20 catheterization was discontinued, but irrigation of the bladder was still kept up. On May 24 the urine showed the presence of much pus, and there was some fever and vomiting. These symptoms disappeared in the course of a few days, the urine became a little clearer, and the patient's appetite and general condition improved. Motion in the lower extremities gradually increased, and on June 24, which was the patient's sixty-fifth day in the hospital, he was allowed to sit up in a chair

for the first time. On July 2 he could move both legs about in bed and flex both thighs, but he could not lift either foot. He had regained good control of both sphincters.

On July 30, 1908, he was put in a walking machine, but had not sufficient strength to push himself along. There was marked foot-drop on the left side. The right lower extremity was stronger than the left, extension of the left foot being almost *nil*. The knee-jerk was present on the right side; not on the left. No spinal deformity could be made out. The urine was free from pus.

The patient left the hospital on December 9 at his own request. He was recently examined by Dr. M. G. Schlapp, who reported that the left leg was still weaker than the right, especially in the peroneal and quadriceps muscle groups. The knee-jerk was present only on the right side. Babinski was present on both sides, but stronger on the right. The Achilles tendon reflex was present on both sides equally. There was slight disturbance of the pain and temperature sense from a point six inches below the knees down to the feet. There was less disturbance of the tactile sense. Dr. Schlapp's conclusion was that there was a lesion of the cord involving the anterior horns, or a lesion of the anterior roots in the dorsolumbar region.

The chief interest in this case centres in the fact that, notwithstanding the very pronounced dislocation of the fragments (¾ inch), the spinal cord necessarily subjected to great pressure should not have been more seriously damaged. The unfavorable result of the operative treatment of this group of cases by laminectomy is well known, and in those rare instances when this operation is said to have been of benefit, the query naturally arises whether equally favorable results might not have been obtained by conservative treatment only.

TUMOR OF THE SPINAL CORD.

Dr. Otto G. T. Kiliani presented a woman, fifty years old, who was brought to the German Hospital by ambulance on April 25, 1908. There was complete loss of power in the lower extremities, and severe pain in the back upon the slightest motion. Her symptoms dated back eight years, when she had an attack of malaria which confined her to bed about three weeks. Shortly after this she complained of pains under the left ribs and in the

spinal region, which became so severe that sedatives were necessary to relieve her. About eighteen months ago she first began to complain of pain in the left lower extremity, and about the same time she noticed that the right leg was cold and numb. These sensations of paræsthesia soon also involved the left leg, as well as the lower abdomen. Subsequently, there was loss of power in both lower extremities.

The symptoms in this case, Dr. Kiliani said, led to the diagnosis of an extramedullary intradural tumor of the cord, involving the eighth and ninth dorsal segments, and an operation was done in May, 1908. Upon exposing the dura in the region indicated, it was observed that it did not pulsate, and its puncture and incision was followed by the escape of only a moderate amount of cerebrospinal fluid. No tumor was found, but the entire pia was studded with small disks, resembling mother-of-pearl, which were afterwards demonstrated to be composed of cholesterin. This condition, the speaker said, he had never before observed, and at the time it led to the suspicion that he was dealing with a meningitis. The opening in the canal was then lengthened upwards, and under the sixth and seventh dorsal segments he found a tumor, which was shelled out without much difficulty or loss of blood. It was encapsulated, and moderately adherent to the dura. Following its removal, there was a free flow of cerebrospinal fluid. The dura was entirely closed with catgut. The wound healed primarily, and the patient made an uneventful recovery. There was a gradual improvement in her symptoms, and she was now able to walk fairly well.

This case, Dr. Kiliani said, had been reported by him *in extenso,* with illustrations, in the " Festschrift " issued in connection with the fortieth anniversary of the German Hospital in New York, in 1909.

TUMORS OF THE SPINAL CORD.

Dr. George Woolsey read a paper with the above title for which see page 289.

Dr. J. Ramsay Hunt said he thought the results referred to by Dr. Woolsey were the most favorable that had thus far been reported. Out of six consecutive cases of extramedullary tumors of the cord, there had been four practical cures, a successful extirpation with recurrence and only one death.

In addition to the cases reported by Dr. Woolsey, the speaker

said he had seen seven other cases of tumor in or about the cord during the past ten years in which the diagnosis was verified by operation or autopsy. The general diagnosis of tumor in these cases was comparatively easy: the difficulty lay, not in recognizing the fact that we had to deal with a tumor, but in determining the relation which the tumor bore to the cord itself; *i.e.*, whether extramedullary or intermedullary, and, in the latter event, in all probability, inoperable. It was easy to make this distinction in some cases, while in others it was practically impossible.

The feeling was growing, Dr. Hunt said, that an exploratory operation should in the future be done in many more of these cases, and at a much earlier period than had been done heretofore. Of course, the most favorable time for the tumor to be removed was when the symptoms of compression of the cord were first apparent. None of his own cases had come under his observation at such an early date, which showed how backward the general practitioner was, as a rule, in recognizing the true nature of this condition. They were usually allowed to go on until advanced paraplegia had developed. Errors were often made in the interpretation of the root pains and cases have been operated upon for gall-stones, pelvic troubles and appendicitis, when the real nature of the trouble was a spinal tumor, compressing the posterior roots and causing persistent pains of segmental distribution.

Dr. Hunt said there were other conditions of the spinal cord which might simulate tumor. Chief among these were myelitis, multiple sclerosis with localized lesions in the cord and syringomyelia. Rarely, tumors of the cord were situated anteriorly on the surface, so that in their growth they would naturally compress the motor tracts and nerves, sensory symptoms remaining in abeyance. The so-called meningeal cyst might also give rise to symptoms of tumor; they may exist alone or associated with conditions inside of the cord. The speaker emphasized the occasional occurrence of cerebral symptoms and optic neuritis in cases of high cord tumor. It was thought these symptoms were produced by a mild grade of hydrocephalus, due to the damming back of the cerebrospinal fluid. He had no doubt that some of the fatal cases that had been reported during or immediately following operation were to be ascribed to the sudden discharge of cerebrospinal fluid in a brain that had been distended.

Discussing the case that had been shown by Dr. Eliot, the

speaker said he had seen a great many cases of fracture-dislocation of the cord, and he had never observed any encouraging results from laminectomy in those cases. The rule he had laid down in dealing with this condition was a fairly conservative one. If the anæsthesia and paralysis were complete, and the motor and sensory symptoms corresponded in level, he did not advise operation, believing that under those conditions the cord had been crushed and an operation could be of no particular benefit. If, however, the anæsthesia and paralysis were incomplete, and the motor and sensory symptoms were irregular and did not correspond, then he assumed that the cord was not completely crushed, and that an operation done immediately or within forty-eight hours was justified and might prove beneficial. In the treatment of these cases he did not believe in extension, and he had even seen fatal results follow accidental movement of the spine. If severe traction was to be done under anæsthesia, the spinal cord should first be exposed.

Dr. Charles A. Elsberg said that about two months ago he had removed a fibrosarcoma involving the third, fourth and fifth cervical segments, and that the patient was now making a good recovery. In that case he had found it necessary to divide the operation into two stages. Upon opening the spinal canal he had made out a hardening of the cord, and he thereupon incised the dura in order to be certain that he was dealing with a tumor. In doing this he injured the pia arachnoid, and upon inspecting this, a bit of brownish tumor material was seen bulging through the opening. The patient's condition at this time became so precarious that the operation was discontinued. One week later, when the second stage of the operation was undertaken, he was exceedingly surprised to observe that the pia had ripped open, and that the tumor, which was very large, was extruded from the cord and required practically no manipulation to remove it.

In a subsequent case, Dr. Elsberg said, he resorted to the same procedure, merely opening the dura during the first stage of the operation, and finding the tumor bulging through the opening when the second stage was undertaken. He suggested that the method might be applied in cases of brain tumor, making a small incision in the dura and cortex, and at the second operation finding the tumor practically extruded outside of the brain.

Stated Meeting, April 13, 1910.

The Vice-President, Dr. Charles L. Gibson, in the Chair.

OSTEITIS DEFORMANS, WITH PATHOLOGICAL FRACTURE OF THE RADIUS.

Dr. James I. Russell presented a man, 55 years old, in whom, eighteen years ago, both big toes became suddenly swollen in the night, and were red, tender, and painful. His illness did not prevent him from working, and he had entirely recovered at the end of one week. Each succeeding summer for several years he had similar attacks, affecting one or the other great toe.

Sixteen years ago he had a sudden attack of pain in the lumbar region, lasting for three days. Similar attacks recurred each winter with increasing severity. About the same time he noticed that he could not abduct his thighs as well as formerly, and that motion had become steadily more limited. Three years later he had a very severe attack of pain in the lumbar region, radiating into the thighs. This kept him in bed for a month, during the last week of which he had pain and swelling in the left ankle.

During the following seven years, although he was able to work, he noticed a general failure in strength. His back became weaker and began to bow forward. The weakness extended to the thighs and legs, his gait changing to a " bandy or hippy walk," as he expressed it. Six years ago, the spinal deformity having increased and the feeling of falling forward being so marked, he began to walk with the aid of a cane. During the past four years the arms had become weaker, and the head had steadily increased in size. For three years he had used a crutch on the right side, and during that time there had been developing an outward bowing of the right forearm.

On March 23, 1910, while leaning on his crutch, the latter slipped, and during his effort to draw the crutch inward to support the body he heard a snap in the right forearm which was accompanied by sharp pain. The following day he came to the Out-Patient Department of Roosevelt Hospital, where an X-ray picture was taken which showed a fracture of the radius, with a marked dorsal curve and pathological changes in the bone.

At the present time the patient had the characteristic symptoms and bony changes described by Paget in 1877, namely, the attitude and gait; the head was disproportionately large and bowed forward, with the chin almost on the chest. The clavicles were very prominent, the back was bowed; both femurs were bowed outwards, and the tibia forward and outward. The radial arteries were very rigid, and could be seen in the X-ray plate of the forearm.

The etiology of osteitis deformans, Dr. Russell said, was unknown. It was always associated with marked arterial sclerosis, and often with malignant tumors. It affected the sexes about equally. As to its pathology, Steele, who carried the case of Packhard, Kirkbride, and Steele to a fatal termination, offers the following conclusions: "1. Absorption of the compact substance, causing enlargement and confluence of the Haversian canals. 2. Formation of new bone running diffusely through affected and healthy portions. This new bone remains uncalcified and is reabsorbed. 3. The conversion of the medullary substance into vascular connective tissue containing fat cells, giant cells, and leucocytes. 4. As consequence of these three processes, the ordinary relations of the compact substance and medulla are destroyed. The bones become thickened and asymmetrical, but since the new bone tissue remains uncalcified, its elasticity permits of great deformity, etc., and fractures do not occur."

SUBPERIOSTEAL RESECTION OF THE TIBIA FOR OSTEOMYELITIS.

DR. RUSSELL presented a boy, 6 years old, who was admitted to the Roosevelt Hospital, in the service of Dr. George E. Brewer, on March 2, 1909.

His present illness began one week before admission with pain and swelling in the region of the right knee. There was no history of injury. The patient complained of a sharp pain in the right leg, extending from the knee to the toes. It was worse at night. In a few days the leg became swollen, reddened, and tender, especially just below the knee. Movement at the knee-joint was painful, and examination showed a red, tender, fluctuating area on the anterior surface of the tibia, below the knee.

Operation (March 2, 1909).—An incision was made through the soft parts of the periosteum, and a portion of the cortex on

the anterior surface of the tibia was removed. This revealed an abscess cavity, which was drained. The boy's condition immediately improved. His temperature, which had been high, gradually fell, reaching 99° on the sixth day, from which time it fluctuated between 99° and 100° until the twenty-seventh day, when he developed marked tenderness and some œdema over the lower part of the tibia. Two days later the skin and soft parts were divided over the anterior surface of the tibia. The periosteum was much thickened throughout its whole extent. A small trephine opening was made just above the lower epiphysis, and the medullary cavity was found to be infected. The periosteum was then split from epiphysis to epiphysis, and the tibia removed subperiosteally from just below the upper to a point just above the lower epiphysis. The periosteum was then sutured with interrupted catgut, the wound was closed, and a plaster case applied. Five weeks after this operation, the patient fell from a chair, fracturing his right femur, for which a case was also applied.

The patient made a slow but uneventful convalescence, and was discharged, cured, on March 4, 1910, one year after his admission.

In connection with this case, Dr. Russell exhibited a number of X-ray plates, taken each three weeks after the operation, which showed the development of the new tibia; they also showed the fractures as they occurred and were repaired in the new bone during the course of its development.

Dr. Charles H. Peck said he had watched this case for a number of months during the patient's stay in the hospital, and was very much interested to see the reformation of the shaft of the tibia until the patient was now able to use the limb. The case was a good illustration of the power of the periosteum in the reformation of bone.

SARCOMA OF THE CLAVICLE: TOTAL EXCISION.

Dr. William B. Coley presented a boy, 16 years old, whose family history was good and who had always been well until the beginning of October, 1909, when in going down stairs he tripped and fell. Trying to save himself, he caught hold of the banister with his left hand, which brought him up so suddenly that it caused a good deal of strain upon his left shoulder and clavicle.

Shortly afterwards, while riding a motor cycle, the latter broke down and he was obliged to tow it for a distance of ten miles, during which time he held on to the tow iron with the left hand. Towards the end of October he first noticed pain and soreness in the region of the left clavicle, but he did not observe any swelling until a week later. On November 20, 1909, he consulted Dr. Alfred Potter of Brooklyn, who found a fusiform enlargement of two-thirds of the inner portion of the shaft of the left clavicle, and an X-ray was made, which gave the appearance of a typical periosteal sarcoma. The tumor was about the size of an English walnut. No enlarged glands were present. The patient's general health was good; there was very little pain.

Early in November, 1909, Dr. Coley did a total excision of the left clavicle. The patient made an uninterrupted recovery, and left the hospital at the end of ten days. Before leaving the hospital he was put upon the mixed toxins of erysipelas and *Bacillus prodigiosus* in small doses, and these have been continued by his family physician. At the present time, five months after the operation, the patient is in perfect health.

Dr. Coley said that this case would be reported in full in the ANNALS OF SURGERY, in connection with a paper upon the total excision of the clavicle for sarcoma, with end results.

INTERSCAPULOTHORACIC AMPUTATION FOR SARCOMA OF THE HUMERUS.

DR. COLEY presented a boy, 10 years old, whose family history was good and whose past history had no distinct bearing on his present condition. About eight weeks ago he began to complain of slight pain in the region of the left shoulder, elbow, and wrist. Three weeks later he fell on the ice, striking on his left shoulder and upper arm. The arm became useless and the patient was seen by the county physician, Dr. Young, who found a swelling of the upper end of the humerus, loss of power, and evidence of fracture. He put the arm in card-board splints. Three weeks later there was an increase of callus; examination a week later showed marked increase in size. The patient was then seen by Dr. Bellis of Trenton, N. J., who found a very large tumor of the upper end of the humerus with enlargement of the veins. This increased with great rapidity. The patient was then referred to Dr. Coley; examination at this time showed the left humerus

enormously enlarged in its upper third, presenting the appearance of a typical sarcoma; the tumor extended from the pectoral muscle to the middle of the clavicle and posteriorly to the edge of the scapula.

An interscapulothoracic amputation was done. The patient made a good recovery, and was put on the mixed toxins. He was in good health at the present time.

Dr. L. W. Hotchkiss said he had seen a somewhat similar case of sarcoma of the head of the humerus in a young boy, for which he had done an interscapulothoracic amputation. The curious features in this case were that the sarcoma had evidently been mistaken for an inflammatory condition by the physician in charge, and had been incised. The incision had been followed by a rapid local infection, which, upon the patient's admission to the hospital, was recognized as a gas bacillus infection, and was treated by free incisions and irrigations with antiseptic solutions, principally peroxide of hydrogen and formalin. The infection did not become general and the patient recovered. Curiously, the growth in the humeral head seemed to decrease in size at first, presumably as a result of the gas bacillus infection, but when this cleared up it rapidly increased in size, and an amputation was done several weeks later. Death from recurrence, but not local, occurred in a few months.

The suggestive feature about the case was the apparent shrinkage in the growth as a result of the gas bacillus infection, and its rapid increase after the patient recovered from this.

Dr. Coley, speaking of the last two cases shown, said that in the case of total excision of the clavicle for sarcoma, the operation had been done within three weeks after the onset of the symptoms, and in the case of sarcoma of the humerus the operation was done within two or three weeks after the onset of the symptoms. An interesting feature of the cases was that the clinical and pathological signs of malignancy differed materially. In the humerus case, Dr. Ewing reported that the growth was a giant-celled sarcoma of a low degree of malignancy, while as a matter of fact its growth proved to be very rapid.

Dr. Coley said that in two other cases of sarcoma of the humerus where he had done an interscapulothoracic amputation, the patients had died of a recurrence in the spine. In another

case he found the subclavian vein filled with thrombi. That patient was put upon the mixed toxins and lived for about a year, when she died of metastases in the lung.

AMPUTATION OF LEG FOR SARCOMA OF FOOT FOLLOWING FORCIBLE CORRECTION OF FLAT-FOOT.

DR. COLEY showed a boy, 16 years old, who was apparently perfectly well until December, 1909, when he came to the Hospital for Ruptured and Crippled for flat-foot, in the service of Dr. Wisner R. Townsend. Both feet were forcibly stretched and placed in plaster of Paris in a position of marked adduction. At the end of two or three weeks, when the plaster was taken off, a well-marked tumor was noticed below the external malleolus of the right foot; it was a smooth, symmetrical, rounded tumor, projecting about half an inch above the surface, and firmly fixed to the underlying structures. The skin was normal. The tumor grew rapidly in size, and when Dr. Coley was asked to see the case it presented an appearance similar to that just described, only somewhat larger. The overlying skin was normal, excepting that the veins were slightly enlarged. In consistence the tumor was soft but not fluctuating; it was firmly fixed, but apparently not connected with the bone.

A diagnosis of sarcoma was made both by Dr. Townsend and himself, and the patient was sent to the General Memorial Hospital. Under ether, Dr. Coley made an attempt to remove the tumor, which proved to be a highly malignant, extremely vascular sarcoma, originating in the ligaments below the malleolus, and extending down to but not involving the periosteum. The tumor had infiltrated the tissues in all directions beneath the tendons and fascia, involving an area about three inches in diameter. It was impossible to effect its complete removal, but, in the hope of saving the leg, it was decided not to amputate at once, but give the patient two or three weeks' trial with the toxins. This was done, and for a short time there was marked improvement, but at the end of three weeks, the growth again increasing, an amputation was done between the middle and lower third. The wound healed by primary union, and the patient was again put upon the toxins a short time after the operation.

SMALL ROUND-CELLED SARCOMA OF THE NECK.

DR. COLEY presented a man, 41 years old, a heavy smoker, who first noticed a lump in the submaxillary region in April, 1909. This grew rapidly, and by June had reached the size of a hen's egg. His family physician, Dr. Lipset, at first regarded the trouble as an infiltrated gland and treated it with poultices for two weeks, and later lanced it, but only blood was found.

On June 11, 1909, the patient was admitted to the Roosevelt Hospital to the service of Dr. Peck, who stated that he found a very vascular tumor which had invaded the periosteum of the lower jaw. There was also marked infiltration of the muscles and skin. Dr. Peck could not make a complete removal, and gave a hopeless prognosis. A microscopic examination was made by Dr. Hodenpyl, the pathologist to the hospital, and he pronounced it a small, round-celled sarcoma, highly malignant.

The patient was referred to Dr. Coley a few weeks after operation for the toxin treatment, and this was carried out under his direction by Dr. Lipset, the family physician. The patient was at first given four injections a week; later, twice a week and then once a week, and, during the last two months, once in two weeks. The total number of injections given was 56.

Shortly after the treatment was begun, the infiltrated area in the region of the cicatrix gradually softened and receded, and at the end of three months it had entirely disappeared. The patient has remained well up to the present time, eleven months after operation. There is no trace whatever of the disease at present, and he is in perfect general health.

DR. PECK, discussing Dr. Coley's case of sarcoma of the neck, said that when he operated on the patient last June, the tumor was of six weeks' duration. There was considerable infiltration of the skin, and only an incomplete excision was possible. The growth was reported as a round-celled sarcoma, and as a prompt recurrence was expected, the patient was referred to Dr. Coley for injection of the mixed toxins.

BRAIN ABSCESS, SECONDARY TO PELVIC SUPPURATION.

DR. CHARLES H. PECK presented a married woman, 22 years old, who was delivered of her first child three weeks prior to her admission to the Gynæcological Service of Dr. George M. Tuttle,

at the Roosevelt Hospital, on October 31, 1909. The history obtained was that instrumental delivery was followed five days later by a chill, fever, and abdominal pain, which continued up to the date of admission. A large abscess in the left lower abdomen was opened and drained on November 10, 1909, at about 2 P.M. At 3.45, 5 and 9 P.M. of the same day muscular twitchings of the right arm and leg were noted. Twitchings of the same character, lasting several minutes, were noted on November 11, at 6.15 A.M., and on November 12, at 1.00 A.M. On the two following days there was considerable rhythmic twitching, and weakness was noted on the entire right side. On November 17 she first began to complain of severe left-sided headache, frontal and parietal, and vomiting set in. On the next day the headache continued, she vomited twice, there was no twitching, but the right-sided paresis persisted, and the pulse, which had previously ranged between 80 and 96, dropped to 60. The temperature had never been above 100° since the abscess was drained.

The patient was transferred to the Medical Division, in the service of Dr. Evan Evans on November 18, and the next day the following examination was recorded: The patient is a woman of small frame, anæmic, conscious but drowsy; speech slow and deliberate; answers questions slowly.

Eyes: No strabismus; movements normal; right pupil slightly larger than left. With the ophthalmoscope an examination of the right fundus showed the outline of the disc indistinctly, especially to the right; no hemorrhages; macula was seen very clearly. In the left fundus the outline of the entire disc was blurred; vessels tortuous and in the upper part obliterated by œdematous disc; no fibrillation; moderate degree of choked disc; no hemorrhages.

The ears were normal. The tongue deviated to the right on repeated examinations. The right face was slightly flattened; emotional motor paralysis was marked. There was marked weakness of the right arm and leg; the patient was unable to hold up her arm and the grip was much weaker than on the left side. There was a glove-like area of diminished common sensibility in the right hand, extending up to the wrist; marked astereognosis in right hand. The left side of the body and extremities were normal. The wrist, knee, and elbow reflexes were absent on

both sides; no Babinski; slight rigidity of neck; Kernig sign positive. There was fairly well-marked cranial tenderness over the left coronal suture, midway between the base and the vertex; some tenderness over the left frontal sinus.

Dr. Evans made a diagnosis of cerebral abscess, subcortical, in the ascending frontal convolution, near the arm area, exerting pressure on the fibres from the psychosensory area and astereognotic centres in the ascending parietal convolution, and on the anterior portion of the optic thalamus. The patient remained in the medical ward from November 18 to November 21. During this time her temperature ranged from 96.8° to 99°; pulse, from 56 to 72; leucocyte count, from 9300 to 14,300.

On November 21 the patient was transferred to the Surgical Service and operated on by Dr. Peck. A continuous catgut suture was taken through the scalp to control hemorrhage, and a curved flap was made with its base reflected downward. A trephine opening was made over the centre of the Rolandic fissure, and the opening enlarged with a rongeur. A small incision was then made through the dura, and an exploring needle inserted. With the third puncture, about two drachms of thick, yellowish pus was obtained at a point a little behind and slightly above the middle of the fissure, at a depth of an inch and a half or two inches beneath the cortex. Cultures from this pus gave a pure growth of *Streptococcus pyogenes*. A blunt dressing forceps was inserted along the track of the exploring needle, and was partly opened upon its withdrawal, but no considerable quantity of pus was obtained. A drainage tube was then pushed through the brain substance to the site of the abscess, and the dura, periosteum, and flap were sutured around the tube. The brain surface showed nothing abnormal on palpation or inspection.

The patient rallied well from the operation, and on November 24 she had begun to show marked improvement in her mental state and increased power in the right arm and leg. Her temperature was only once above 99.8°, and the pulse ranged from 72 to 100. No pus ever discharged from the drainage tube, and none could be obtained by exploring with a grooved director and slender dressing forceps in the depths of the tract on removal of the tube on the sixth day after operation. Improvement seemed to come to a standstill after about ten days. In the meantime, a hernia cerebri had developed, and had increased somewhat in size. The wound healed without infection.

On December 10, an examination of the eyes showed a decided choked disc on the left side, with an elevation between 1 and 2 mm., and venous hemorrhages to the superior and nasal side. On the right side there was choked disc, with an elevation of from 1 to 2 mm. On December 13 a note was made that the hernia cerebri was about the size of half a lemon. The headaches persisted, and there was no increase in power in the right arm and leg. The patient became much depressed and very homesick, and on December 20 she insisted on going home, against advice. At home her spirits and general condition improved greatly, but her other symptoms persisted practically unchanged until December 26, when a considerable quantity of pus escaped from the hernial mass.

On January 12, 1910, a note was made that since the discharge of pus the paralysis had greatly improved, the patient now being able to walk a few steps and raise her right hand to her face. Her vision was also much better, as were the headaches; the astereognosis was still present. On February 18 the cerebral hernia had entirely disappeared, and all the symptoms had greatly improved. On March 20, when she came to the hospital with her husband to report progress, her mentality was perfectly clear, she was bright and happy, and had gained twenty pounds in weight. Her vision and the eye-grounds were normal, the choked disc having entirely disappeared on both sides. There was still slight facial paralysis and right hemiparesis, although the muscular power in both arm and leg had greatly improved and she walked well with a slight limp. Right astereognosis was still complete, but the glove-like area of anæsthesia had disappeared.

Dr. Peck said the case seemed of interest on account of the rarity of a cerebral abscess secondary to pelvic suppuration being single and amenable to treatment, and on account of its accurate localization prior to operation by Dr. Evans's careful and thorough study of the case. The evacuation of the abscess at the time of operation was evidently imperfect, and owing to its small size and great depth from the brain surface, its attempted drainage while the patient remained in the hospital was unsuccessful, but a track was established along which the pus subsequently found its way, appearing at the surface of the hernia.

SUPPURATIVE CHOLANGITIS; PANCREATITIS; HEPATIC DRAINAGE.

DR. PECK presented a man, 60 years old, who was awakened on the morning of February 20, 1910, at 2 A.M., with a severe, lancinating pain in the upper abdomen, radiating through to his back, followed by chilliness and fever, and on the next day by jaundice. The fever and steadily deepening jaundice continued, and he was admitted to the Medical Service of the Roosevelt Hospital on February 23. His temperature ranged up to 104.4°; the skin and conjunctivæ were deeply icteric, the stools were clay-colored, and the urine loaded with bile. There was marked tenderness and some rigidity on deep pressure over the region of the gall-bladder and ducts. A blood count showed 10,000 leucocytes, with 70 per cent. of polynuclear cells. The patient was transferred to the Surgical Service on February 24 and operated upon at once, the diagnosis being stone in the common duct, with cholangitis. The man stated that he had had attacks of gall-stone colic twenty years ago.

Operation.—A vertical incision was made through the upper part of the right rectus. The liver was swollen and dark in color, with rounded edges, very tense on palpation, and showing some evidence of perihepatitis along the edges of the right lobe. Neither gall-bladder nor ducts could be seen for some time. The pylorus was tightly adherent to the under surface of the liver by dense adhesions. The head of the pancreas was uneven, hard to the feel, and considerably thickened. The posterior peritoneum to the right of the duodenum was incised, and this organ was then lifted and rotated to the left, exposing the posterior surface of the head of the pancreas. No stone could be palpated in the lower portion of the common duct.

The adhesions of the pylorus and upper duodenum to the under surface of the liver were then divided and separated with great difficulty, and a structure which looked like an enlarged common duct was exposed. Incision into this proved the part next to the liver to be a diminutive, shrunken gall-bladder, and below it the common duct. A probe passed easily into the duodenum and upward into the hepatic duct, no stone being found. Bile streaked with pus escaped when the duct was incised, and cultures from this showed the *Staphylococcus aureus*. A drainage tube was passed into the hepatic duct and secured with a fine

catgut suture. A large tube was passed down to the opening in the gall-bladder and duct, and a large rubber tissue and gauze drain below in Morrison's pouch. The wound was then carefully sutured excepting at the exit of the drains.

Bile drained freely from the tubes, from 126 c.c. to 415 c.c. each twenty-four hours. Both the jaundice and the constitutional symptoms improved steadily. Bile passed on into the intestine very soon, for on the third day the patient had a yellow, liquid stool. By the sixth day the temperature had fallen to normal, the stools were normal in color, and the jaundice had entirely disappeared. The duct drain was removed on the tenth day, and bile continued to discharge through the wound until the twenty-third day, when it entirely ceased. The patient was allowed out of bed on the twenty-eighth day, and left the hospital a week later, cured.

Speaking of this case, Dr. Peck said there had evidently been a chronic cholecystitis, probably associated with gall-stones, present for years, as shown by the shrunken gall-bladder and the dense, old adhesions. The pancreatitis seemed to be confined to the head of the pancreas, and was subacute or chronic in type, as no fat necrosis nor evidence of acute inflammation was seen. The cholangitis was acute, with tense engorgement of the liver, and a distinct streaking of the bile with pus as it escaped through the incision in the common duct. Cultures taken from this pus showed a growth of *Staphylococcus aureus*. As this is a most unusual organism to find in this location, it was possible that contamination occurred through some error in technic, although care was taken to prevent this, and the fluid was obtained directly from the opening in the duct. As no calculi were found and there was no demonstrable mechanical obstruction in the ducts, the cause of the acute onset of the cholangitis was uncertain. The prompt relief of symptoms afforded by the hepatic drainage was striking, in view of the apparent violence of the cholangitis and the seemingly hopeless outlook.

HYDRONEPHROSIS FROM VALVULAR URETERAL OBSTRUCTION; PLASTIC OPERATION ON KIDNEY PELVIS.

Dr. Peck presented a man, 39 years old, an engineer, who was admitted to Roosevelt Hospital on February 6, 1910, with the history of having had during the past year several attacks of

pain in the right lumbar region, all similar in character. The last one began ten days before admission with pain at the right costovertebral angle, not radiating to the thigh, groin, or testicle, and later tenderness on pressure in the same area. He had also suffered from nausea, and had vomited once. The pain, nausea, and tenderness recurred at intervals of two or three days until admission. It was somewhat relieved by hot applications or hot tubs. There was no history of increased frequency of urination or of sudden variations in the amount passed, nor had he observed any sand or gravel or blood in the urine. He had never been jaundiced nor passed clay-colored stools. The pain at the costovertebral angle was never violent, but dull and distressing in character. In two of his previous attacks he had what he described as a " sore line " (not a radiating pain) from the right costovertebral angle to the right testicle. Repeated analyses of the urine had proved negative. On four occasions he had had left-sided pain, but less severe than on the right, and without tenderness. His general health was not impaired, and his appetite and digestion remained good. There were no constitutional symptoms. Blood examination negative. Physical examination was negative, with the exception of an area of slight tenderness at the right costovertebral angle and on palpation of the kidney region. No mass could be felt. An X-ray of the kidney region was negative.

A cystoscopic examination was made by Dr. Edward F. Kilbane on January 31, 1910, who reported as follows: The bladder urine was clear in gross. The bladder was able to hold eight ounces of fluid without discomfort. Its mucous membrane was normal. The prostate was enlarged and nodular; the division between the lobes could not be made out, but the gland projected as a whole into the bladder for a considerable distance, forming quite a fossa behind. Both ureteral orifices and the entire trigone were carried forward into the bladder by the prostate. The left ureteral orifice was normal in appearance, and a catheter was easily passed to the pelvis. Urine started to flow immediately, and the rate of flow was rapid. At first the urine was considerably blood-stained, probably due to trauma; later it became much clearer. Indigo-carmine appeared within ten minutes.

The right ureteral orifice appeared to be œdematous, and it

was difficult to introduce the catheter, which met with several obstructions and could not be passed beyond a point twelve inches from the orifice. Pressure of the catheter at this point caused pain, which was referred to the head of the penis. The catheter on the opposite side passed three inches further. Several catheters were introduced on the right side with the same result. A small quantity of urine was collected from this side, which contained a large proportion of pus.

After withdrawal of the catheters, both orifices were observed for some time. The left side secreted at frequent intervals, with considerable force, a good-sized stream deeply stained with indigo-carmine. From the right side there would occasionally come a small quantity of lightly stained fluid. This came with very little force.

Cystoscopic Diagnosis.—Prostate somewhat enlarged. Left kidney showed good functional activity; right ureteral obstruction; kidney on that side probably infected. These observations were confirmed on February 2, when the right ureter excreted a decidedly blood-stained fluid three times per minute.

Exploration of the right kidney region was decided upon, and the operation was done on February 7, 1910. The kidney was explored through an oblique lumbar incision, and delivered with some difficulty owing to adhesions to the capsule at the upper pole. The pelvis of the kidney was found to be tense and much dilated, pouching down behind the ureteral implantation in such a way as to cause complete valve-like closure of its upper orifice. No stone could be felt. An incision was made through the cortex at the convex border into the pelvis, where a small stone was discovered and removed. It was not lodged in the ureteral orifice at the time of operation. With the collapse of the pelvis the kink in the ureter straightened out, and a spiral kidney probe was passed from the opening in the cortex through the pelvis and ureter into the bladder without difficulty. An elliptical segment was then excised from the pouching part of the kidney pelvis, and the wound closed with two tiers of No. 0 chromic gut. This obliterated the pouch and corrected the faulty implantation of the ureter. The long probe was left in the ureter to prevent further kinking when the kidney was replaced, and the wound sutured. A rubber drainage tube was passed into the pelvis through the wound in the kidney cortex, alongside the probe, and two mat-

tress sutures of heavy plain catgut were passed through the kidney substance and lightly tied, one of them around the tube. These controlled all hemorrhage. The kidney was replaced and the wound closed in the usual way. The end of the flexible probe was bent down over a gauze pad and secured with adhesive plaster. This probe was removed without difficulty at the end of twenty-four hours. Drainage through the tube amounted to only a few ounces, and it was removed on the fifth day. The wound healed cleanly; all sutures were out by the seventh day and all drainage from the wound had practically stopped by the eleventh day, when the patient was allowed out of bed. When he left the hospital, on the thirteenth day after operation, he was passing from 60 to 80 ounces of normal urine per day, and he had remained perfectly well since.

On April 11, 1910, cystoscopy by Dr. Kilbane showed both ureteral orifices normal, the right secreting three or four times a minute, a good-sized stream being sent out with considerable force. The wound of the kidney pelvis had evidently healed without leakage.

It was altogether probable, Dr. Peck said, that the obstruction was originally caused by the calculus, which was just about of a size to lodge at the ureteral orifice and obstruct it. After the dilatation of the pelvis had occurred, however, the pouching produced a valvular action which was sufficient in itself to cause complete obstruction. The temporary introduction of the metal probe while the kidney was replaced, and until fixation without kinking was secured, he believed was of assistance in the effort to restore the patency of the ureter.

MYELOMA OF THE LONG BONES.

Dr. Frank S. Mathews read a paper with the above title, for which see page 388. In connection with his paper, Dr. Mathews showed a number of cases illustrative of the same.

Dr. Charles N. Dowd said the communication of Dr. Mathews was among the most important which the Society had recently had. The Society had always shown great interest in the general subject of sarcoma, and probably no one had more keenly appreciated the difficulties and possibilities of the subject than the late Dr. McCosh. As long ago as 1897, while considering the way in which cures have followed incomplete operation for sarcoma, he stated that "we have yet a great deal to learn

about sarcoma," and in 1904 his interest in the subject was so great that he presented to the Society a tabulation of 125 cases of sarcoma that had come under his personal care.

In that paper, after discussing the unsatisfactory state of our knowledge of this subject, he said that he had no doubt, "but that in another quarter of a century, the class of *neoplasms* that we know as *sarcomata* would be divided into many other distinctive groups, very probably with entirely new names;" and in the same paper he stated that "this whole subject is at the present day so vague and unsatisfactory, that I do not know a richer field for research, and I have been surprised that more of our younger clinicians and pathologists have not persevered in their investigation of this subject."

But after a careful consideration of his topic, with the aid of competent pathologists, he had to be content with dividing his observations according to the shapes of the cells, and the inclusion of myxomatous, lymphatic, and fibrous tissue, studying the history of these groups, as they were located in the different portions of the body.

Dr. Mathews' consideration of *myeloma,* so far as the speaker knew, was the pioneer effort in this Society to separate a group of benign tumors from that indefinite class which we call *sarcoma,* and this separation is exactly in accord with the process which Dr. McCosh foresaw several years ago.

We are not sure how definitely this group can be separated, but we may well be convinced that there is such a group; a very large number of so-called *benign sarcomas* have been reported.

In every general discussion on the subject, we find one or more surgeons relating instances of cases which have recovered after very incomplete operations; usually these recoveries have resulted to the surprise of the surgeon, but there have been so many of them that we must believe in their existence.

Several surgeons have done much to add to our knowledge of the peculiarities of these growths. König, for instance, many years ago called attention to those cases of bone sarcoma which contained many giant cells, and he cured a number of them by curetting and chiselling.

Mikulicz, in 1895, advocated resection for certain sarcoma of the long bones rather than amputation, and Bloodgood has studied the question most thoroughly, and has found that conservative operations, for a large number of cases, are successful.

From a pathological stand-point, Adami and Sutton give their pathological endorsement to this group of tumors. The proof is still more conclusive, if, in addition to this, pathological and clinical and surgical studies are continued as shown in the present paper. One must appreciate that much has been accomplished toward the practical separation of one group of benign tumors from the so-called sarcomas. In clinical work, there are two guides in dealing with these growths: one, clinical observation, the other, the report of the pathologist.

In the past these have often been contradictory; for instance, while the second case which is here reported suffered from disturbance in the tibia for three years, the symptoms were very annoying for only three months. The patient was taken to a very able orthopædic surgeon, who believed that the condition was probably a bone abscess, in spite of the X-ray appearance; hence, the clinical study indicated either a benign process or a sarcoma of a very low grade of malignancy, but the pathologist reported it sarcoma, and anxiety was felt about the future of the patient for several years, although the amputation was done just below the middle of the femur, but well above the infiltrated tissue.

The third case was kept under observation for a considerable period after operation. It had been considered a growth of granulation tissue, but the report was definite for sarcoma. A careful consultation was held with the parents and the physician as to the advisability of amputation. The boy, however, was using his leg perfectly well, playing ball, running bases, and doing the other things which healthy boys do, and the result has shown how wise it was to depend on the clinical rather than the microscopical examination.

In endeavoring to separate these cases, surgeons will therefore have to be guided by both clinical and microscopical reports; and until it is possible to know more definitely just which are benign, the use of the mixed toxins may be advocated in their treatment after operation.

Dr. William B. Coley said he agreed with Drs. Mathews and Dowd that it was important to try and differentiate from the group of ordinary sarcomas these so-called encapsulated central growths of the bones, which were in many cases benign or so slightly malignant that a local operation was all that was necessary in many of them. Thus far they had been grouped as periosteal or central sarcomata or myeloids. The speaker said

he did not wish to imply that all of these were non-malignant. In Bruns's clinic, among 53 cases of tumors of the long bones, 9 were well three years after the operation, and of these, 4 were periosteal and 3 were myeloid.

Dr. Coley said he thought the encapsulated tumors that had been described by Dr. Mathews should be taken out of the class of sarcomata.

Replying to the statement of Dr. Mathews that spindle-celled growths rarely affected the tibia, the speaker said that he had observed a number of such cases, and he had shown one such case at a meeting of the Association of the Greater City of New York in which the patient was well twelve years after curettage. He was strongly in favor of conservative measures in dealing with malignant growths of the long bones, and he had written a number of papers bearing upon that aspect of the subject. Many such cases could be cured by curettage and resection, and as an additional safeguard he believed in the use of the mixed toxins.

Dr. Mathews, replying to Dr. Coley, said it was Sutton who made the statement that practically all medullary tumors were of this benign type and should be regarded as myeloma, and that spindle-celled sarcoma in the region was very rare. In regard to tumors originating in the marrow, the fact should be borne in mind that the marrow naturally had round cells, and that a round-celled tumor in that region might be quite benign, whereas if it were situated elsewhere it would be regarded as malignant. The speaker expressed the hope that the pathologists might learn more about the character of these growths, so that they could come to the aid of the surgeon. Thus far, the X-ray had proved of material aid in the diagnosis.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittance for Subscriptions and Advertising and all business communications should be addressed to the

Annals of Surgery,
227–231 South Sixth Street,
Philadelphia.